

THE ADOPTION OF FOREIGN TECHNOLOGY
BY CANADIAN INDUSTRY

Proceedings of a Workshop
sponsored by the Science
Council of Canada
Industrial Policies Committee

May 1981

Proceedings are published by the Science Council of Canada to share with a wider audience of interested readers the ideas and perspectives brought to Council conferences or seminars by experts in a variety of fields. The papers presented and views expressed in these Proceedings are not necessarily endorsed by the Science Council.

Copies of

**THE ADOPTION OF FOREIGN TECHNOLOGY BY
CANADIAN INDUSTRY
A Proceedings**

are available
free of charge from:

The Publications Office
Science Council of Canada
100 Metcalfe Street,
Ottawa, Ontario K1P 5M1

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Catalogue No. S524-13/1981E
ISBN 0-662-11534-1

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FOREWORD

Over the past few years, the Science Council has stressed that Canadian industry can only remain internationally competitive if it effectively incorporates up-to-date technology in its products and manufacturing processes. An important element in remaining technologically competitive is a firm's ability to develop its own technology internally. Such a capability allows a firm to have exclusive access to advanced product or production technologies which can give its products a price or performance advantage over foreign goods.

While such a strategy is obviously the most desirable way of obtaining a technological trading advantage, a number of circumstances limit its application in Canada. The high degree of foreign ownership in the Canadian economy and our large number of small, domestically-owned manufacturing enterprises means that many firms in Canada must obtain their technological capability from abroad, either in the form of technology transferred from a parent firm or by obtaining technology on a licensing basis. The important role such forms of technology acquisition play in the Canadian economy, and the number of changes that are occurring in these forms of technology acquisition, encouraged the Science Council to sponsor a seminar on the subject in May 1980.

The seminar was designed to examine several important aspects of technology acquisition in Canada. These included: the relative decline of Canadian subsidiaries as the first recipients of their US

parent firms' technology; the nature of innovative activity in Canadian firms; the role technology acquisition plays in such activity; and the challenges faced by small Canadian firms attempting to license technology from abroad. In addition, the seminar reviewed the experience of three Canadian firms in the technology acquisition process. These firms included a Canadian subsidiary which has traditionally obtained its technology on a transfer basis from its US parent and is now in the process of establishing its own technology development capability; a small Canadian-owned firm which has traditionally relied on its ability to license technology from abroad in order to remain competitive nationally; and finally, a large Canadian-owned firm which has gained an international leadership position through the development of its own technological base.

The following proceedings contain the papers presented at the seminar, plus a summary of the discussion which emerged following each presentation. Not only were we fortunate to have a number of interesting papers, but the contribution of the participants in the discussion periods added a number of valuable insights. I would like to take this opportunity on behalf of the Science Council to thank all those who participated in the seminar and who helped make it a success.

Donald Pollock
Chairman
Science Council of Canada
Industrial Policies Committee

I. TECHNOLOGY TRANSFER BY MULTINATIONALS



**Trends in the Transfer of US
Technology to Canada**

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As a recipient of US technology, Canada exhibits three distinguishing characteristics. First, more new US products are manufactured in Canada than any other country except the United Kingdom. Second, on average, manufacture of new products is initiated in Canada before any other country. Third, current trends suggest that the priority accorded Canada as a recipient of US technology is gradually declining.

*This last trend may be due to a variety of factors. One appears to be the increasing experience of US firms in rival host countries. As US firms expand operations overseas, their preference for Canadian manufacturing projects appears to decline.**

Introduction

This study is based upon a sample of 954 significant new products introduced in the US between 1945-1976.¹ The international spread of manufacturing for these products was traced in detail. All cases of foreign manufacturing by affiliates or independent licensees of the innovator were compiled for each product. The resulting data base is used to analyse trends in the transfer of US technology to Canada.

Host Country Preference

Of the products in the sample, 343 are being manufactured in Canada. This total exceeds that for any other nation except the United Kingdom, and represents almost 10 per cent of all transfers recorded for the sample of products.

The total number of transfers indicates the priority accorded various countries by US firms, but it does not describe the age of the technology being transferred. The priority accorded host countries can also be measured in terms of the speed by which products are introduced to those countries. The average time lag between introduction in the

*This article is drawn from research supported by the United States National Science Foundation and the Harvard Multinational Enterprise Project.

US and introduction in a given host country can be used to measure the speed of introduction, but this approach has several drawbacks. First, products have different life cycles, and comparison of average time lags will not account for variations in the set of products introduced in each country. Second, a transfer late in a product's life cycle to a given country will increase the average time lag for that country, while the absence of such a transfer in any other country will actually enhance its relative priority. For these reasons, a more complex measure of priority was developed.

Table 1 - Transfers to Leading Host Countries

Nation	Number of New Products for which Local Manufacturing Commenced before January 1977
UK	360
Canada	343
Australia	271
Japan	256
France	230
Brazil	218
Mexico	205
W. Germany	196
Italy	151
Argentina	102

Country Entry Sequences

This approach analyses country entry sequences for a set of host nations. Entry sequences were compiled for each of the products in the sample. For example, the country entry sequence for one product appears in Table 2.

Entry frequencies for a set of 20 principal host countries were compiled from these entry sequence observations. Entry frequencies are calculated by determining, on a country-pair basis, the

percentage of cases in which manufacturing was initiated in one country before another.

Table 2 - Country Entry Sequence for Product 251

Host Country	Year of Initial Production
Canada	1960
UK	1961
Mexico	1964
Japan	1969
Australia	1970
France	1971
S. Korea	1976

Frequencies for each country-pair are derived from the formula:

$$F_{ij} = \frac{\sum_{k=1}^N \frac{A_{ij}}{A_{ij} + A_{ji}}}{N} = \frac{\sum_{k=1}^N \frac{A_{ij}}{N}}{N}$$

F_{ij} is the percentage of products manufactured in country i or j which first appear in country i . N represents the set of product lines manufactured in countries i or j . A_{ij} indicates that production was initiated first in country i , A_{ji} indicates that production was initiated first in country j . Each N product line k was assigned to A_{ij} or A_{ji} .

The result of these calculations is a matrix of 380 entry frequencies. Since F_{ij} plus F_{ji} sums to one, only one frequency for each country-pair is presented in Table 2.

As Table 3 shows, products tend to be manufactured in Canada before all other countries except the UK. While exactly half of all products manufactured in the UK or Canada appear first in Canada, over

Table 3 - Frequency With Which 57 US-based Multinational Enterprises Initiated Manufacturing for 954 New Products in Country A before Country B, 1945-78

Country A	Country B																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. UK	.500		.635	.678	.683	.720	.731	.722	.771	.803	.879	.839	.867	.902	.924	.941	.934	.977	.983	.991
2. Canada		.609		.656	.654	.716	.692	.705	.756	.779	.850	.866	.866	.907	.909	.939	.947	.982	.982	.988
3. Australia				.542	.561	.602	.622	.606	.670	.707	.793	.775	.805	.862	.892	.925	.910	.963	.978	.989
4. France					.503	.550	.556	.552	.648	.683	.772	.733	.781	.820	.858	.903	.898	.965	.973	.937
5. Japan						.541	.556	.546	.633	.715	.735	.745	.772	.791	.831	.895	.902	.963	.975	.983
6. W. Germany							.509	.505	.583	.629	.683	.705	.704	.777	.806	.844	.879	.943	.968	.984
7. Brazil								.503	.569	.632	.728	.702	.748	.798	.828	.884	.891	.954	.972	.936
8. Mexico									.596	.641	.726	.707	.768	.781	.851	.890	.894	.961	.971	.990
9. Italy										.554	.633	.625	.665	.695	.776	.854	.834	.942	.961	.974
10. Belgium											.553	.569	.577	.624	.680	.773	.786	.913	.951	.975
11. Colombia												.503	.560	.572	.684	.758	.762	.894	.953	.971
12. Netherlands													.515	.553	.632	.733	.744	.906	.935	.967
13. Spain														.529	.604	.707	.748	.901	.938	.968
14. S. Africa															.566	.676	.728	.874	.926	.962
15. Argentina																.632	.667	.857	.923	.952
16. India																	.529	.857	.745	.900
17. Philippines																		.727	.838	.889
18. S. Korea																			.647	.750
19. Taiwan																				.600
20. Ireland																				

60 per cent appear in Canada before Australia, 65 per cent before France and Japan, and so on. This confirms that Canada is given priority over other nations as a recipient of US technology.

Table 3 presents entry frequencies for the entire 1945-1978 period. In order to examine trends over time, the data in Table 3 were divided into three subsets. Products were classified according to whether they were first introduced in the US between 1945 and 1954, 1955 and 1964, or 1965 and 1975. Tables similar to those of Table 3 were compiled for each subset. These tables appear in Appendix I.

Examination of the appendix tables reveals that Canada's position in the transfer sequence has remained fairly constant over the three periods. It receives priority over all other countries in the 1945-1954 period, is second only to the UK in the 1955-1964 period, and re-emerges as the highest priority host nation in the 1965-1975 period.

Although its rank remains constant, an examination of individual country-pair frequencies reveals that the level of priority accorded Canada compared to many other nations has declined over this period. This can be seen by comparing the sum of all frequencies in the country row for each table. This measure, defined as:

$$S_i = \sum_{j=1}^{19} A_{ij}$$

reflects the overall priority accorded Canada relative to the other 19 countries. The sum of these entry frequencies for Canada declines substantially over the three periods. For comparison, the sums for the UK and Australia entry frequencies remain fairly constant (Table 4). Increasingly, US firms are producing new products elsewhere before initiating manufacturing in Canada.

Table 4 - Sums of Country Entry Frequencies for Three Periods

Host Country	1945-54	1955-64	1965-75
Canada	16.264	15.288	14.977
UK	15.935	15.779	15.926
Australia	14.63	13.612	14.920

Motives

There are several possible explanations for this phenomenon. First, production costs, particularly labour, have increased in Canada more than in the United States.² Second, prospects for the reduction of Canadian tariffs may have discouraged US investment.³ Third, Canada's economy has not grown as rapidly as that of other nations.⁴ Fourth, the investment climate there may have been seen as deteriorating in recent years.⁵

Unit Labour Costs (1965=100)

	<u>1972</u>	<u>1975</u>
Canada	122.0	183.7
USA	118.1	168.3

In addition, as US firms expand their scanning horizons, other nations appear more attractive than Canada.⁶ In the past, US firms have been attracted to Canada because of its geographic proximity, cultural and economic similarity, and identical market characteristics. Canada represents a low-risk market for initiating foreign expansion of a product line. However, as US firms gain experience overseas, operations in more distant and dissimilar markets appear less

risky, and one result of this is a relative decline in the priority accorded Canada as a recipient of US technology.

The Experience Effect: A Test

US firms with substantial foreign experience may exhibit a diminished preference for Canadian manufacturing projects - a hypothesis that can be tested by comparing entry frequencies for a set of experienced firms with a second set of country sequence observations from a less experienced sample of firms.

The country entry frequency technique permits a specific definition of the firm's prior experience in individual host countries. Each observation in the aggregate frequency matrix (Table 3) can be classified according to whether the firm had prior experience in each of the host countries for a country-pair. The result is a set of four conditional entry matrices corresponding to the four conditions below.

1. NN - the firm had no prior manufacturing experience in either country i or j at the time that manufacturing for product line k was initiated in one of the two countries.
2. PN - the firm had prior experience in country i but none in j when manufacturing for product k was initiated in country i.
3. NP - the firm had no experience in country i but prior experience in j when manufacturing for product k was initiated in country i.
4. PP - the firm was present in both countries when manufacturing was initiated in one of the two countries.

The hypothesis above can be tested by comparing entry frequencies in the NN and PP tables. If inexperienced firms exhibit greater preference for low-risk Canadian projects, entry frequencies for Canada in the NN matrix will be greater than those in the PP matrix.

These two matrices appear in Appendix II. For ease of comparison, the sums of country row frequencies were compiled and presen-

ted in Table 5. Note the sharp decline in overall priority accorded Canada when the firm is already present in rival host countries. The sum of entry frequencies for Canada in the PP matrix is over 20 per cent lower than in the NN matrix.

Table 5 - A Comparison of Location Priorities for Firms With and Without Experience in Local Host Countries

Host Country	Sum of Entry Frequencies from Country Row in NN Matrix*	Sum of Entry Frequencies from Country Row in PP Matrix*	Difference
Canada	17.471	13.743	-3.728
U. Kingdom	15.581	13.386	-2.195
Mexico	14.000	11.566	-2.434
Brazil	13.007	10.766	-2.241
W. Germany	13.047	12.043	-1.004
France	12.753	11.569	-1.184
Australia	12.253	11.279	-.974
Colombia	10.975	9.638	-1.337
Spain	10.091	10.306	.215
Japan	10.056	11.614	1.558
Italy	9.845	9.909	.064
Argentina	8.778	7.573	-1.205
Belgium	8.412	10.030	1.618
S. Africa	8.584	7.881	-.703
Netherlands	7.795	10.328	2.533
India	7.391	7.761	.370
Ireland	3.144	6.524	3.380
Phillippines	3.582	4.158	.576
S. Korea	1.613	3.720	2.107
Taiwan	1.622	6.206	4.584
	190.00	190.00	0

$$* S_i = \sum_{j=1}^{19} F_{ij}$$

This trend has a significant impact on the transfer of technology to Canada. It should be noted that a similar effect appears for the United Kingdom. In fact, all of the high priority countries, including Mexico, Brazil, France and West Germany exhibit lower overall entry frequencies when the firm is already present in rival host countries. This general pattern suggests that high-risk premiums are initially associated with the commencement of projects in "secondary" host countries. However, as firms become familiar with such secondary markets, uncertainty about these markets declines. Subsequent projects in such countries are evaluated on an equal basis (e.g., at identical discount rates) with high priority countries. The result is a sharp rise in the firms' preference for "secondary" markets.

Such a shift is most pronounced in the case of Canada. Canadian projects benefit most from the inclusion of a risk premium in evaluations of foreign projects, because they generally bear the lowest risk premium. In contrast, Canadian projects suffer the greatest decline when risk premiums are removed from project evaluations.

Summary

Canada has retained its premier position as a recipient of US technology, accounting for 10 per cent of all US technology transfers in the 1945-78 period. On average, Canada also receives US technology before any other country. However, a variety of forces are at work to change this. One of the most important is the growing experience of US firms in third countries. More experienced US firms exhibit a reduced preference for Canadian manufacturing projects.

Notes

1. For a description of this sample see, Raymond Vernon and W.H. Davidson, Foreign Production of Technology-intensive Products by US-based Multinational Enterprises, Washington DC, National Science Foundation, 1979.
2. US Department of Commerce, International Economic Indicators, March 1979.
3. As a signatory of the GATT, Canada is committed to reductions of tariffs for a wide range of products.
4. A comparison of GNP levels, adjusted for inflation and exchange rates, reveals that Canada's economy grew at less than average rates for industrial nations from 1970-1975. International Monetary Fund, International Financial Statistics, various issues.
5. The financial press has pointed out several instances where this was an important consideration (potash in Saskatchewan, asbestos in Quebec, ITT Rayonier).
6. W.H. Davidson, "The Location of Foreign Investment Activity: Country Characteristics and Experience Effects," Journal of International Business Studies, Fall 1980.

Table 2 - Frequency With Which 57 US-based Multinational Enterprises Initiated Manufacturing for 338 Individual Products in Country A before Country B, 1955-64

Country A	Country B																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. UK		.522	.698	.708	.710	.700	.767	.803	.788	.824	.855	.886	.861	.916	.917	.916	.949	.971	.994	.994
2. Canada			.627	.663	.639	.639	.749	.757	.749	.860	.777	.827	.833	.923	.905	.906	.973	.983	.993	.993
3. Australia				.528	.500	.541	.623	.654	.671	.717	.697	.769	.771	.876	.849	.891	.921	.943	.991	.993
4. Japan					.520	.528	.589	.644	.627	.725	.773	.730	.761	.805	.826	.844	.948	.957	.991	.991
5. France						.525	.590	.649	.651	.690	.709	.763	.772	.852	.881	.880	.922	.964	.981	.991
6. Mexico							.587	.644	.600	.690	.701	.773	.798	.813	.849	.852	.955	.955	1.00	.991
7. W. Germany								.553	.500	.632	.628	.616	.667	.760	.760	.773	.897	.917	.987	.979
8. Italy									.504	.561	.575	.621	.638	.728	.807	.818	.892	.919	.986	.987
9. Brazil										.603	.619	.652	.694	.733	.794	.800	.892	.933	.981	.988
10. Netherlands											.511	.521	.557	.623	.681	.850	.981	.911	.981	.987
11. Belgium												.505	.533	.625	.658	.671	.833	.860	.961	.980
12. Colombia													.590	.618	.725	.696	.841	.869	.939	.961
13. Spain														.573	.636	.631	.849	.870	1.00	.979
14. S. Africa															.509	.547	.773	.829	.966	.971
15. Argentina																.522	.737	.824	.939	.966
16. India																	.714	.750	.922	.964
17. Philippines																		.556	.909	.900
18. S. Korea																			.889	.889
19. Ireland																				.500
20. Taiwan																				

Commentary by Professor William Davidson:

I would like to expand on some points raised in my paper. My experience began with the Harvard Multinational Enterprise Project survey of the 180 largest US multinational firms. We studied their international operations and patterns of foreign investment; Tracing the Multinationals¹ describes this study in some detail.

To an economist, it's surprising that, according to the number of subsidiaries created, Canada is the single largest recipient of US direct investment. We expect direct investment to be a function of market size (the Canadian market is relatively small), or transportation and tariff costs. We expect a neighbouring country with low tariffs to be served through exports, rather than direct investment.

Several years ago we began a second project that focussed specifically on the international transfer of technology. We developed a data base covering 954 significant US innovations that were introduced in the United States between 1945 and 1978. My paper describes and analyses this specific body of data. The diffusion of each of these innovations to foreign markets was traced. For our purposes, technology transfer was defined as the initiation of manufacturing of a product in a foreign country. Of those products, 343 were transferred to Canada;² only Great Britain had a slightly larger number of transfers.

It is important to understand the age of these transferred products. Technology is "time dependent;" a transfer early in a product's life cycle is very different from one that occurs later in the cycle. To measure the priority of Canada in time as well as in number of transfers, we measured country sequences of investment.

Table A is based on the larger data base of almost 1300 three-digit product lines for the 180 multinationals. For all these products, 59.1 per cent appeared in Canada before the United Kingdom, 69.3 per cent appeared in Canada before West Germany, etc. Based on

Table A - Frequency With Which 180 US-based Multinational Enterprises Initiated Manufacturing for SIC 3-digit Industries in Country A before Country B, 1900-76

[illegible]

this statistic, Canada has priority over all other host countries. Further analysis generated Table B, which also supports this finding, although the UK has a slightly higher priority for this sample of 954 more recent high-technology products. We were surprised at Canada's ability to attract investment based on primary country characteristics.

The market similarity between Canada and the United States is partly responsible for Canada's pre-eminent position as a recipient country. American firms can transfer technology to Canada with very little alteration; they don't have to modify any aspects of their marketing mix, as Canadian consumers respond in more or less the same way as Americans to a product. In other countries, however, additional costs are incurred to modify the package before it can be transferred, and companies are more uncertain about operating in foreign environments.

This uncertainty is very important. The preference given Canada in the immediate post-war period was higher than at present; it has declined since the war by roughly 20-25 per cent. That is, the priority given other countries has increased about 20-25 per cent over time. The primary reason for that decline, in my view, is the increased experience of US companies. Once firms become established overseas they no longer place a high premium on the similarity of the Canadian market.

It could also be argued that a number of other trends or factors have contributed to the decline in priority. Manufacturing costs, for example, have increased in Canada more than the United States. The investment climate may have deteriorated, or the Canadian market may not be growing as fast as other markets. The tests I've conducted, however, indicate that this decline can be traced to the experience profile of the American firms that are transferring technology.

The decline could be seen as negative and should be of concern to Canadian policy makers. The next step is to try to discern precisely which factors are contributing to it. Is it some fundamental change in the Canadian environment or is it something beyond the control of the Canadian market?

After that, how technology is transferred becomes the issue. (Table C). One of the striking patterns that emerges from the data is the use of licensing in different countries. Only 5 per cent of all transfers to Canada are conducted through independent licensees.

The pattern is not the same for any other country. (Almost 90 per cent of all transfers in Canada are to wholly-owned subsidiaries.) There are countries, like the UK, which are similar to Canada in their level of technology transfer, but the UK exhibits a rate of licensing three times as high as that in Canada.

Decisions about how technology is transferred are a function of four different characteristics: technology, corporate, country, and industry.

Technology characteristics are very important.³ Radical new technologies tend to be transferred internally, while less important technologies and incremental innovation are usually transferred via licences. These findings suggest that the higher the level of technology associated with a product, the more likely it will be transferred internally to an affiliate rather than an independent licensee. To a certain extent, therefore, the greater percentage of licensing in some of the other countries reflects the fact that the technology is not as valuable at the time of transfer, while a lower level of licensing can mean a transfer of newer, or more significant, technologies. This is an important consideration when analysing the low rate of licensing in Canada.

Table C - Transfers of 580 Products, Classified by Recipient and Host Country, 1945-78

Percentage of Transfers Via:					
Host Country	Independent Licensees	Minority-owned Affiliate	Majority-owned Affiliate	Wholly-owned Affiliate	Total Number
Canada	5.0%	6.2	1.1	87.8	180
Colombia	7.7	11.5	26.9	53.8	26
Netherlands	10.0	30.0	8.3	51.7	60
Argentina	15.6	17.2	6.3	60.9	64
United Kingdom	17.0	12.9	6.7	63.4	194
Brazil	17.1	6.7	5.7	70.5	105
Australia	17.5	12.6	4.9	65.0	143
Mexico	17.6	30.6	13.9	38.0	108
Italy	23.3	14.4	4.4	57.8	90
France	26.2	5.4	10.0	58.5	130
Spain	26.3	14.1	3.5	56.1	57
Belgium	27.1	5.1	8.5	59.3	59
Germany	30.5	17.9	2.1	49.5	95
Turkey	30.8	38.5	15.4	15.4	13
Sweden	36.8	31.6	0.0	50.0	12
S. Africa	37.5	20.0	0.0	42.5	40
India	41.7	8.3	0.0	50.0	12
Switzerland	41.7	8.3	0.0	50.0	12
Taiwan	44.4	0.0	5.6	50.0	18
Japan	45.9	53.4	0.7	0.0	146
Venezuela	58.3	20.9	0.0	20.8	24
Peru	62.5	25.0	0.0	12.5	8
Other	49.6	10.8	3.3	36.3	240
Total	25.9%	17.1%	5.3%	51.6%	1 843

When companies consider a transfer, they analyse the returns from the two key strategic options - licensing or direct investment. In a country like Canada, the costs of internal transfer are going to be relatively low, because the entire package, including such things as personnel, can be transferred without modifications. Therefore, the

returns from internal transfer are relatively high. On the other hand, the licensing returns reflect the efficiency of the markets for technology, which in turn reflects the degree of sophistication of domestic industry. Part of the difference between Canada and the UK arises from the fact that, in Great Britain, some firms are world scale competitors, more sophisticated technologically, more willing to pay the true value of technology, and hence better recipients; whereas in Canada less sophisticated companies in many sectors cannot provide as efficient a market for these technologies.

It can be argued that the United Kingdom has a higher level of licensing because it has a larger and more efficient market for technology. Returns from licensing are higher because British companies are more willing to pay the full value of the technology.

Another country characteristic is evident in the example of West Germany. West Germany has almost twice as high a licensing rate (30.5 per cent) as the United Kingdom. Like the UK, Germany has sophisticated industry, but differences in consumer tastes, factor costs and legal conditions make internal transfer less desirable. Significant modifications in the product package have to be made to enter the market successfully. This reduces the attractiveness of internal transfer and results in a higher rate of licensing than that in the UK.

Another variable is national policy. It is a difficult thing to assess, but its effects are obvious when viewing the data. In India, 41.7 per cent of all technology transfers are licensed. Clearly, an unfavourable investment climate reduces the attractiveness of internal transfer. Much of Indian industry is not developed enough to serve as an effective or efficient recipient of technology. The licensing percentage is high because India has national sector screening criteria with three categories of industry. In the first, the government allows no direct investment; in the second it permits joint

ventures; in the third it permits direct investments. These restrictions definitely affect the level of licensing.

In Japan, the importance of national policy is well known. Wholly-owned subsidiaries are rarely permitted in any sector.

Further research might establish whether there is a trade-off between the percentage of transfers by licence and the total number of transfers to any country. Certain countries like India receive a smaller number of transfers than one would expect given the characteristics of the market. Are fewer transfers occurring because the government sets a stringent line on the channel and the mode of transfer? Some participants at this seminar may want to provide information on this issue. My untested hypothesis is that a number of firms, in India for example, would decide not to enter a market at all rather than license according to government policy.

Before drawing any conclusions about Canada's position as the lowest user of licensing arrangements to transfer technology, other aspects of the transfer process must be considered. For example, the age and significance of the technologies being transferred and the characteristics of the company are important. Companies with high levels of R&D choose not to license, and prefer to transfer technologies internally. Companies with existing subsidiaries overseas also choose not to license, but firms inexperienced in foreign investment will. Taking these factors into account explains most of the variance in the percentage of licenses in Canada compared with other countries.

The "wild card," it seems to me, is government policy. I am not sure how government policies are evolving in Canada, but in less developed countries this variable may be the most critical determinant of licensing rates. A pro-licensing policy will increase the percentage of technology transfers to licensees, but I wonder whether there isn't an offset in the total number of transfers.

Table D - Transfers of 480 Products: Classified by Type of Recipient and Period of US Introduction

Percentage of Transfers to:					
Period of US Introduction	Independent Licensees	Minority-owned Joint Ventures	Majority-owned Joint Ventures	Wholly-owned Subsidiaries	Total Number
1946-55	29.2%	18.2%	6.2%	46.3%	982
1956-65	23.6	20.1	4.5	51.9	628
1966-75	18.1	4.7	3.9	73.4	233
Total	25.9%	17.1%	5.3%	51.6%	1 843

To my own surprise, there is a fairly significant reduction in the rate of licensing over time.

In Table D, between 1946 and 1955, transfers to locally-owned companies accounted for about 50 per cent of the total. These transfers were "passive" - that is, the American company did not control the local firm. But in 1966-1975, only 22 per cent of all transfers went to locally-controlled recipients in the host country, reflecting a fundamental change over time. I had believed that licensing should have increased between the first decade and the second. At a minimum it should have stayed the same, or increased in the latter period. Over the last fifteen or twenty years, in any industry, the number of competitors has grown dramatically. At the same time government policies in many countries are shifting. In particular, more emphasis is being placed on the acquisition of technology by licensing. As a result, licensing should have increased.

I think there is a tremendous difference between the public stance of most countries and the realities of transfers. Mexico is a good example. Under Mexican law, it is legally impossible for a foreign firm to own a majority position in a Mexican company, but there are many American and other foreign companies that have or will have a majority ownership in new companies. These companies then transfer technology to the newly created majority-owned or wholly-owned subsidiaries.

Tables E to G illustrate how different firms transfer technology. I've developed a measure which asks: given the characteristics of the company and the technology, what is the probability of that technology being transferred internally?

For example, if a product outside of the parent's principal industry is being transferred for the first time to a country in which the firm does not have a subsidiary, there's a 66 per cent chance that the technology will be transferred internally through the formation of a new subsidiary. When the technology is in the transferor's principal line of business, other things being equal, there is a sharp increase from 66 to 87 per cent in the probability of internal transfer. If this is a new technology, in the transferor's principal line of business, that has not been transferred before, and if that company has a subsidiary in the host country, there is a 97 per cent chance that the technology will be transferred internally. Under such conditions licensing rarely, if ever, occurs.

Table F demonstrates that as R&D is intensified there is a much higher probability of internal transfer. These relationships are useful in predicting the types of technology transfer patterns for different products and companies. I don't have the country and industry characteristics in the same detail. The missing variable is government policy, the importance of which I don't know how to measure.

Table E - Prior Transfers, Relation to Principal Line of Business, Affiliate Status and Probability of Internal Transfer

Probability of Internal Transfer	Prior Transfers	Technology is in Transferor's Principal Line of Business	Subsidiary Exists
.66	0	No	No
.56	1	No	No
.40	5	No	No
.87	0	Yes	No
.81	1	Yes	No
.68	5	Yes	No
.90	0	No	Yes
.85	1	No	Yes
.75	5	No	Yes
.97	0	Yes	Yes
.95	1	Yes	Yes
.91	5	Yes	Yes

Source: W.H. Davidson and D.G. McFetridge, "International Technology Transactions and the Theory of the Firm," forthcoming.

The speed of technology transfer is another important concern. According to Table G, of the 175 innovations introduced in the US between 1945 and 1950, 8.6 per cent appeared in a foreign market within one year. But in the most recent five-year period, almost a third of those innovations are being transferred abroad within the same amount of time. The speed of transfer is accelerating dramatically for a number of reasons, the first being that once a firm has created subsidiaries and acquired some operating experience, the cost of transfer is reduced sharply. With a subsidiary, there is less uncertainty, and the managerial, marketing and manufacturing facilities are already present. Second, when there is more competition in the industry, companies have to move faster. Third, the export cycle between intro-

duction in the US and introduction overseas may be speeding up. There may not be any change in strategy; it is simply done more quickly. Fourth, and I raise this as an issue, is the effort of foreign governments to entice investment into their countries. This effort seems to be an important variable.⁴ In a number of cases, the investment

Table F - Age, Prior Transfers, R&D Intensity and the Probability of Internal Transfer

Probability of Internal Transfer	Age	Number of Prior Transfers for the Product	R&D Intensity
.89	1	0	.02
.87	5	0	.02
.85	10	0	.02
.84	15	0	.02
.85	1	1	.02
.81	5	1	.02
.79	10	1	.02
.77	15	1	.02
.74	1	5	.02
.68	5	5	.02
.65	10	5	.02
.63	15	5	.02
.93	1	0	.05
.91	5	0	.05
.90	10	0	.05
.89	15	0	.05
.90	1	1	.05
.87	5	1	.05
.86	10	1	.05
.85	15	1	.05
.82	1	5	.05
.78	5	5	.05
.76	10	5	.05
.74	15	5	.05

Source: Op. cit., Davidson and McFetridge, forthcoming.

decision is primarily driven by the financial incentives offered by host governments.

Table G - Initial Transfer Lag, Transfer Rate and Non-Transfer Ratio for 954 New Products: By Period of US Introduction

Period of US Intro- duction	Number of Inno- vations	% First Introduced Abroad in:				% Not In- troduced Abroad as of 12/30/78	Average Annual Trans- fer Rate
		One Year	One to Three Years	Three to Five Years	Five Plus Years		
1945-50	175	8.6%	9.1%	9.0%	62.9%	11.4%	.187
1951-55	151	8.6	9.3	12.6	54.2	15.9	.218
1956-60	153	8.5	15.7	17.6	43.2	15.0	.202
1961-65	185	23.2	19.4	14.6	23.4	19.4	.247
1966-70	170	28.2	16.5	11.8	7.1	36.4	.257
1971-75	120	32.2	13.2	4.9	n.a.	49.7	.393
Total	954	170	134	112	312	226	.244

Notes

1. J.P. Curhan, W.H. Davidson, and Rajan Suri, Tracing the Multinationals, Cambridge, Mass., Ballinger, 1977.
2. See previous paper, p. 10.
3. See W.H. Davidson and D.G. McFetridge, "International Technology Transactions and the Theory of the Firm," forthcoming.
4. See for example, Investment Incentives in Western Europe, US Chamber of Commerce, Washington DC, 1978.

DISCUSSION

Silverman: In Table F, did you examine rate increases in the generation of technology (especially electronics) over that period of time, or the fact that once the basic technology is generated the rate of change is increased rapidly?

Davidson: The number of innovations in each five-year period has declined over time, but I wouldn't infer anything from this. I am tempted to say that the rate of generation has slowed dramatically in some sectors, but not electronics. I would like to understand the composition of innovation by industry over time, but I have not addressed this. A large part of the explanation may be that more recent innovations are occurring in faster moving industries but total transfer activity begins to level off in the early 1970s.

MacDonald: The question is: Has the rate of transfer by US companies fallen, or, if the total transfers have fallen, is the gap being filled by European and Japanese companies?

Davidson: Part of the levelling off is due to the fact that there are fewer technologies being introduced, but I'm convinced that there is more international competition. A larger share of the recipients' needs are being met by foreign competitors and small marginal US competitors.

MacDonald: It would be interesting to find sectors with a background of total transfers, which included more than US multinationals. In the chart (p. 30) that showed the decline of licensing in Canada and a fairly high level of licensing in the UK, Germany, Japan, etc., did you look at non-tariff barriers to product entry or to investment in those countries?

Davidson: In view of the limited research completed, I'd like to tentatively categorize those as part of government policy. Non-tariff barriers are reflections of national policy about technology transfer. For example, countries differ in the stringency of their screening criteria for technology transfer.

**Industrial Patterns in Early and Late Adoption of
New Products in Canada**

Chris DeBresson
Science Council of Canada

In my investigation of innovation in Canada, I found that a few sectors, particularly non-ferrous metals, smelting, and iron and steel, were early adopters of foreign technology. The recent work of Bill Davidson and Raymond Vernon seems to confirm this.¹ Their work centres on the large innovative multinationals, which probably constitute a very small section of all the multinationals that operate in Canada. However, these firms play an important role in bringing technology to this country.

Professor Davidson studied firm-specific factors in the timing of US technology transfers. My point of view is that of the host country, Canada. To what extent is early adoption of technology a general pattern in Canadian industry? Are there policy implications which emerge from the pattern of technology adoption in Canada? My results are provisional, and may not be representative of all industry, but I am reasonably confident they are significant.

As far as I can tell, early adoption by Canadian industry of foreign technology is not a generalized pattern. This assessment is based on an examination of products and processes that were new to Canada from 1945 to 1975. In gathering the data, we asked innovating firms if they knew of any foreign predecessor for their products or processes, or of similar products or processes. Table 1 deals with part of that data.

Our principal purpose in compiling this information was to examine the links between the supplier and the user. However, in order to produce relevant findings, we had to know whether the technology supplied or used was really new or simply an adoption and adaptation of foreign technology.

We have not verified the respondents' statements that their product was a "world first." Only a few experts in each industry could evaluate these statements. Also, innovation may be of different technical or economic importance, or of universal or specific use.

Our data (Table 1) indicate that only 12 Canadian industries are either world first or second in adopting technology:

- rubber products
- smelting and refining of non-ferrous metals
- pulp and paper
- iron and steel
- hardrock mining, especially mining services or support industries to mining
- aircraft and parts
- machinery and equipment
- engineering services
- telecommunication equipment
- electrical industrial equipment
- electrical wire and cable
- railway transport.

In other manufacturing industries, there is no clear pattern of early adoption.

Early adoption can only be attributed in part to the behaviour of multinationals. In the case of iron and steel, which is almost totally Canadian owned, early adoption of new technology is due to an aggressive and technologically capable domestic industry.

If the pattern of early transfer by US multinationals to Canadian subsidiaries that Bill Davidson has described is not general in Canadian industry, how can Canada best take advantage of the early adoption of technology made available by some US multinationals?

We can assume that some American multinationals will continue early transfers of technology to Canada, particularly in new industries when newly arrived multinationals establish plants abroad. Because Canada has a policy of being a good host country and allowing total foreign control, it will likely remain a privileged foreign country in the transfer of process innovations (where firms want to remain proprietors of their process technology).

In Table 1, the last column shows the total frequency of innovations in a given industry. The early adopters are those that

Table 1 - Percentages of World First, Second, Third and Fourth Bivariate Frequency Distribution

Industry (3 digit SIC)	World 1st	World 2nd	World 3rd	World 4th	Don't Know	Missing Data	Total	Frequency
Misc. Metal Mines	55.0	5.0	-	5.0	5.0	30.0	100.0	20
Asbestos Mines	55.6	11.1	0.0	0.0	22.2	11.1	100.0	9
Misc. Services In- cidental to Mining	53.3	0.0	6.7	0.0	6.7	33.3	100.0	15
Meat & Poultry Prod.	12.0	28.0	12.0	4.0	12.0	32.0	100.0	25
Rubber Products	13.3	60.0	6.7	6.7	-	13.3	100.0	15
Plastics Fabricating	25.5	1.8	0.0	0.0	-	72.7	100.0	55
Pulp & Paper Mills	47.9	12.5	0.0	2.1	16.7	20.8	100.0	48
Paper Box & Bag Mfg.	18.8	0.0	0.0	0.0	31.3	50.0	100.0	16
Iron & Steel Mills	29.7	8.1	2.7	2.7	16.2	40.5	100.0	37
Smelting & Refining	32.3	3.2	3.2	3.2	9.7	48.4	100.0	31
Machine Shops	15.0	10.0	0.0	-	15.0	60.0	100.0	20
Misc. Metal Fab.	16.1	3.2	6.5	-	3.2	71.0	100.0	31
Agricultural Imp.	11.8	2.9	2.9	0.0	14.7	67.6	100.0	34
Misc. Machinery & Equip. Mfg.	34.7	10.8	2.0	1.2	10.8	40.6	100.0	251
Office & Store Machinery Mfg.	25.0	0.0	0.0	5.0	0.0	70.0	100.0	20
Aircraft & Parts Mfg.	36.3	5.9	6.9	6.9	7.8	36.3	100.0	102
R.R. Railing Stock	26.7	6.7	6.7	0.0	6.7	53.3	100.0	15
Shipbuilding & Repair	27.3	9.1	0.0	9.1	0.0	54.5	100.0	11
Telecommun. Equip.	25.8	13.6	0.8	0.0	3.8	56.1	100.0	32
Elec. Ind. Equip.	47.9	9.6	4.1	5.5	11.0	21.9	100.0	73
Elec. Wire & Cable	38.5	23.1	0.0	0.0	7.7	30.8	100.0	13
Misc. Elec. Prod.	13.3	11.1	13.3	0.0	4.4	57.8	100.0	45
Clay Products	23.1	7.7	0.0	0.0	15.4	53.8	100.0	13
Misc. Non-metallic Mineral Products	17.9	3.6	3.6	3.6	0.0	71.4	100.0	28
Misc. Petroleum & Coal Products	68.8	0.0	0.0	0.0	18.8	12.5	100.0	16
Pharm. & Medicines	38.9	2.8	1.4	1.4	13.9	41.7	100.0	72
Paint & Varnish	37.5	6.3	0.0	0.0	6.3	50.0	100.0	16
Industrial Chemicals	15.4	4.6	4.6	1.5	49.2	24.6	100.0	65
Misc. Chemicals	11.6	17.4	0.0	1.2	4.7	65.1	100.0	86
Scientific & Prof- essional Equipment	24.0	0.0	0.0	0.0	0.0	76.0	100.0	50
Railway Transport	32.0	16.0	-	-	4.0	48.0	100.0	25
Electrical Energy	44.4	0.0	-	-	11.1	44.4	100.0	9
Engineering & Scientific Services	27.4	4.1	1.4	1.4	14.4	51.4	100.0	146
Total	22.8	9.3	2.2	1.8	8.7	49.2	100.0	2 314

Note: Industries with low frequencies or very high percentage of missing data have been eliminated. In industries where technology is readily accessible and applications are numerous and specific, uncertainty about degree of novelty (and therefore missing data) is common.

answered that their products were world second, third or fourth adoptions. The low percentages in these categories imply that when Canadian manufacturers adopt foreign technology, they tend to be late adopters. However, Table I also shows that in most industries world firsts are more numerous than early adoption.

All the innovations (both world firsts and adoptions) we analysed are in either primary or secondary manufacturing. To identify the innovations we searched through the trade journals and then asked industrial experts to isolate innovations and firms with innovations. A questionnaire was sent to each firm about the identified innovation(s); a total of 2 314 were confirmed. Thus, we have used at least two sources to learn if a Canadian firm was the first in Canada to commercialize a product in a given year - an expert or a trade journal, and the firm itself. We also surveyed all users of R&D; Canadian resident holders of recent patents (1971-76); and a stratified random sample of firms in the 80 most integrated domestic industries.

As Table 2 shows, using the same decade breakdown as Professor Davidson, the rate of early adoption of foreign technology has slowed down. The first row in Table 2 also shows that the percentage of world firsts has not decreased over time. But the rate of world seconds has clearly declined, at least since the middle sixties. There is no clear pattern reflecting later adoption of technology although much of the analysis must be qualified by the importance of missing data.

The decline of early adoption may not be as great as the data indicate. When asked about innovations made thirty years ago, people tend to remember the most notable ones, usually their world firsts. In the most recent period, they're not always sure whether their innovations are world seconds, or the result of later adoption. This accounts for the increase in the missing data column in the most recent period. However, these results seem to confirm the trend identified by

Bill Davidson that larger US multinationals have begun to transfer technology more slowly to Canada.

Let's turn to the policy questions. US-based multinationals will probably remain a crucial source of technology for Canada, given our limited technological capability. How can Canada best benefit from early adoption? This question is of major importance, because the bulk of benefits arise from being an early, but not necessarily the first, adopter.

Table 2 - Frequencies and Percentages for World Firsts, Seconds, Thirds and Fourths

Decade of Adoption	1945-54	1955-64	1965-75	Not in any Previous Decade	Totals
World 1st	41 31.1	114 29.8	389 37.3	122 16.1	666 28.8
World 2nd	28 21.2	71 18.6	92 8.8	25 3.3	216 9.3
World 3rd	5 3.8	12 3.1	28 2.7	6 0.8	51 2.2
World 4th	5 3.8	13 3.4	18 1.7	5 0.7	41 1.8
Don't Know	10 7.6	39 10.2	84 8.0	69 9.1	202 8.7
Missing Data	43 32.6	133 34.8	433 41.5	529 70.0	1138 49.2
Totals	132 100.0	382 100.0	1044 100.0	756 100.0	2314 100.0

The Economic and Learning Benefits of Early Adoption

Paradoxically, there is very little advantage in being the first to innovate and develop a product. Costs are hard to control. The upper

limit of R&D budgets cannot be predicted. New technology is almost invariably laden with bugs and not very reliable. It is often of limited application, which impedes diffusion. Markets for which the technology is designed can often be hard to infiltrate. In short, the economic returns often accrue not to the leader, but to the follower. These returns are not the obvious ones such as royalties, but those learned from the experience of others.

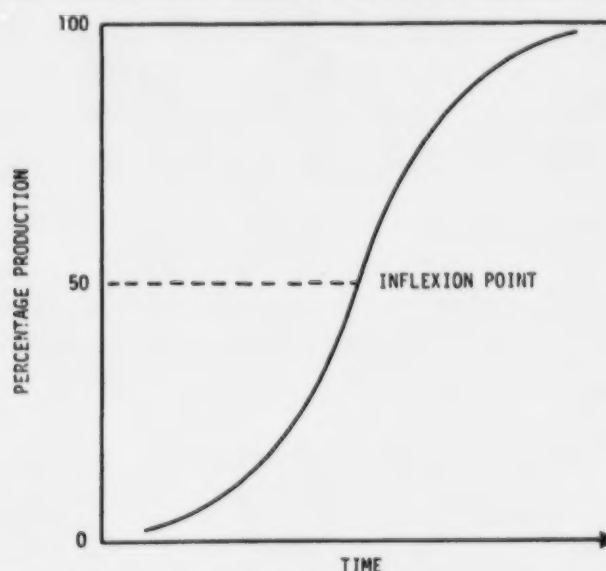
Any new technology, whether product or process, needs a shakedown period. For this reason, equipment makers like to keep their first machines and test them to destruction. One complaint I've heard from machine manufacturers in Canada is that they don't have enough funds to keep their first machinery.

This is true in general for innovation. Usually only the second or third generation of a new technology will incorporate the key elements which make it reliable. Better components are designed and more adequate materials are chosen. New materials are often crucial to resolving production problems and reducing the cost of manufacturing, but such cost reductions will only start to appear later.

The early adopter, therefore, can measure the risks associated with imitation, improvement and adaptation. He can predict the size of his R&D projects, the specific problems of adoption and adaptation, and compare them to his expected returns. While there will still be some risks, the economic benefits can be clearly identified and market surveys can be more accurate.

With an innovation, entrepreneurial profits are made during the first half of the diffusion process. In Edwin Mansfield's curve (see Figure 1) the vertical axis shows the percentage of production in an industry as a result of a new process, the horizontal axis shows time.

Figure 1 - Mansfield Diffusion Curve



At the beginning, the diffusion rate is slow. It accelerates until 50 per cent of industrial production is made with the new process and then it levels off. Entrepreneurial profits are made in the lower half of the curve or the early adoption stage, when an individual manufacturer's costs are under the industry's costs; when you pass the 50 per cent point, the price at which you sell the product on the market starts decreasing dramatically.² In the latter phase of diffusion, new technology is adopted to make sure that manufacturing costs less than the market price. This is a "defensive" adoption strategy.

The benefits of "learning by doing" also occur in the early stages of adoption. The Japanese have based their technological strategy for decades on a systematic early adoption of foreign technology. At the beginning, they didn't attempt to innovate. Now, they innovate as a matter of course, because they have acquired the technical skills. Canada should encourage firms to be both innovators and

early adopters of technology, and make sure it reaps the benefits of both.

The American Connection in Perspective

Foreign (particularly US) investment in Canada is one of the major sources of technology transfer. Early and intelligent adoption is essential as a means of developing our own capabilities. As the Gray Report on foreign investment pointed out in 1972, the question is not whether Canada adopts foreign technology, but rather how much and in what ways. How can adoption of foreign technology increase Canada's technological capability?

For example, Dupont Canada was world second in adopting an intermediate polymer around 1970. In the process of adoption its plant had to be scaled down to the size of the market; to accomplish this, Dupont Canada evolved a catalyst technology which cut the cost of production in intermediate polymers dramatically. This catalyst is now being used in all intermediate polymer production around the world. This is an example of a high-technology field in which a Canadian firm is a world leader.

This example raises a number of concrete policy questions. Did Dupont Canada acquire enough benefits from sales of this know-how? Does it receive royalties? Was this catalyst know-how used for other applications in chemical technology? How did it contribute to increasing overall technological capability in the Canadian chemical industry?

The mode of technology transfer is vitally important in determining what benefits are derived. It can be affected by the host country's environment and its government's policies. Japan, Spain and Yugoslavia, for example, have broadly different social systems, yet all control the import of technology. In Japan, the mode of transfer was dramatically controlled but the amount of technology that was imported increased.

Notes

1. Raymond Vernon and W.H. Davidson, Foreign Production of Technology Intensive Products by US Based Multinationals, Harvard Business School Working Paper pp. 79-5.

2. This supposes that production is not totally inhibited by restrictive trade practices within an industry or by cross-industry competition.

Commentary by Professor P. Richardson, School of Business, Queen's University:

Professor Davidson's paper offers us some interesting data on a significant Canadian issue - the adoption of technology. His data base is large US multinationals. We all recognize that most of those US multinationals have subsidiaries in Canada. When we look at his figures, we see that Canada has more new products introduced by these companies than any other country, but at the same time there has been a decrease in licensing as a mode of transfer. What we are seeing, (termed by Professor Davidson "Canada's changing priority for transfers") is simply a reflection of the penetration of Canadian industries by multinational corporations.

The increase in penetration by the multinationals and rising levels of internal transfer of technology between 1945 and 1975 may have occurred simply because during this period in Canada, a large number of subsidiaries of multinationals were established. The priority, the numbers and the trend in technology transfer may be due to the population of subsidiaries, or the lack of domestic firms who are able to develop "me too" competing innovations as rapidly as in other countries.

West Germany and Japan seem to have realized that the turnaround time for developing technologies is important and that companies which can import foreign technologies, modify them and re-export them, are a very important weapon in industrial strategy. The priority Canada appears to receive may again simply be a reflection of non-tariff barriers or of the industrial strategies that these countries have adopted and which we've failed to adopt.

Canada appears to be given priority in technology transfer but this priority has been declining in recent years. In Professor Davidson's Table G (p. 37), showing the rate of transfer 'abroad from US multinationals, Canada was given priority when transfer was relatively

slow - 8.6 per cent within one year in the 1945-55 period, versus 32 per cent today. Our priority now seems to be somewhat less.

Professor Davidson's data considers manufacturing technology, not product technology; that is, the export of the manufacturing plant and not the product. The data do not show whether the product was previously exported to Canada or other countries. We might get a manufacturing plant in Canada, but other countries may already have the product technology that is being exported to us through the creation of a branch plant. What Professor Davidson's data tell us is only that manufacturing technology is being exported. My question is, in terms of this technology transfer, how important is the process, and what benefits does it bestow on a country to receive the manufacturing facilities - especially when in Canada it seems to have been within the branch plant, "miniature replica" type of company? What advantages are gained, apart from some jobs and the ability to supply our own market demands? What priority does Canada receive in the export of product technology? For intermediate products this question is of great significance to purchasing industries. When technology is transferred its benefits should extend beyond the domestic economy to its development and application in new markets. I don't know if Professor Davidson's data enables us to address this fully.

Professor Davidson's paper also points out that as US firms gain experience internationally, they seem to accord Canada less priority in the transfer of new technology. Obviously, if there is already a manufacturing plant in country A and also a manufacturing plant in country B and country A is Canada and country B is Taiwan or Korea, it is not only the market for technology but other factors, such as labour costs, which will be taken into account before manufacturing facilities are established. But Professor Davidson's paper looks at the decision to establish offshore manufacturing facilities, not the transfer of technology per se. Are we the recipients of US bounty by getting these

plants early? What does it mean for us? Professor Davidson's work does not offer much here.

Canada is low-risk in that it offers these US firms a market with which they're relatively familiar, but this does not give us very much of a competitive technological advantage. It gives us branch plants; it gives us manufacturing; but the companies in the manufacturing sector that have done well are the subsidiaries that have been given a global technology mandate by their parents in the US - companies like Pratt and Whitney and Black and Decker. What these companies have received from their parents is not simply first access to manufacturing a product outside the US, but the technological competence to take a technology and do something with it. Product mandating is a very important aspect of this whole issue.

This study may also have some implications for tariff policy. Crookell and Wigley, among others, have pointed out the benefits Canadian subsidiaries derive from truncation and their relationship with parent firms. With the relatively early implementation of new products or processes in these companies in Canada, they have had an advantage over domestically-owned producers. The result has been that the ability of domestic producers to come up with competing innovations rapidly has been eroded. Canadian firms are unable to turn the technology around fast enough. In Japan and West Germany, with tariff and non-tariff barriers and an industrial strategy, domestic firms have time to adopt these technologies themselves and to compete more effectively with the multinational branch plants.

The key issue is Canada's priority when US firms are transferring major new process innovations abroad. If they are transferring a standard technology that can be easily copied, which isn't a major advance, along with the new product, that doesn't mean much to us. If we were the first, outside the States, to get the new manufacturing process, it could be very important, especially if we had the ability to do something with the process.

I conclude that we should not be overly concerned about our declining priority because it might mean that our own domestic base has more time to respond to technology advances imported by subsidiaries.

Commentary by Professor J. Britton, Department of Geography, University of Toronto

I find myself in very substantial agreement with Professor Richardson's comments. The paper Professor Davidson circulated is a pertinent and valuable one for this conference for two reasons: it presents some interesting data, and it prompts us to focus on a set of questions which are very important for Canadian economic development. As a discussant, I have chosen to consider some of the implications of this paper from a Canadian standpoint - the disadvantageous position with which a host economy must contend. Professor Davidson's paper has addressed only one part of the large process of technology transfer, a process whereby informational transactions are made between firms, or within the same firm, operating in different countries. The technology may be concerned with products (the subject of this paper) with technical and business systems, and/or with production process. Unfortunately, when Canada imports technology the transfer is often made in such a way that there is very little requirement for product or production innovation either in the receiving firm or in its potential domestic suppliers. Truncation of branch plants and the whole economy, as we know well, is the result. The concern with the manner in which Canada receives technology is a major part of the subject of technology transfer, of interest to many of us here, that is not addressed by Professor Davidson.

Of course, technology may be transferred in a way that permits creative use of the imported ideas in new products and in product derivatives. There is also the possibility for other domestic firms with supply links in producer services and manufacturing to enter a learning phase stimulated by any initial transfer. If relevant occupational groups such as designers or engineers are provided with the opportunity to enrich their experience and to create second generation products - even new products, a developmental potential may be recognized. Evidence suggests, however, that this does not occur as often as Canada would like.

Professor Davidson's paper is concerned with product transfers created by exclusively US direct investments. What are Canada's benefits from these transfers? Although "variety of products and production jobs" has been the favoured response in the past, Canada's poor export performance can be traced to US direct investment in secondary manufacturing. Furthermore, the vulnerability of the Canadian industrial economy to corporate failure in the United States, and Canada's poor business record of R&D and product innovation do not suggest that these technology transfers do much directly or indirectly to support the development of the Canadian technological system in domestic firms. Professor Davidson points out that more new US products are manufactured in Canada than in most other countries. Is this a good thing? I doubt it, because of the manner in which the transfer occurs. Communications allow domestic US organizations to extend their North American branch operations in Canada very easily.

In the absence of domestic technology generation, and considering the small amount of successful Canadian innovation, perhaps we should be concerned with Canada's decline in priority as a recipient of US technology. On the one hand, the situation might create a market stimulus for Canadian producers. On the other hand, however, we might be inclined to generalize, from recent events in the North American auto industry, that the Canadian economy is highly vulnerable to US business failures imported as part of an inferior technology package.

It is appropriate we should evaluate the benefits derived from the transfer of US technology into Canada, but we should also be concerned with the transfer of product technology from countries that are more successful innovators than the United States, for example, Japan and West European countries. How does the US compare as a donor when one examines these origins of new ideas? Are firms from West European countries and Japan as likely as US firms to create truncated Canadian operations? Do they establish enterprises which are free to attain world, or North American, product mandate status and which are

encouraged to innovate? Are these countries as strongly tied to the direct investment route of technology transfer to Canada?

Perhaps more pertinent questions raised by Professor Davidson's paper are: Why has Canada's position as a recipient of US technology via multinationals declined? What economies compare favourably with Canada as hosts for direct US technology transfer?

In answer to the first question Professor Davidson has suggested: increases in Canadian labour costs; prospects for reductions in Canadian tariffs; slow growth in the Canadian economy; a perceived decline in the Canadian investment climate and the increased adventurousness of US firms in more distant, dissimilar locations that have large market potential. The data substantiating this decline are for the periods 1965-75 compared with the earlier period of 1945-54. The factors listed by Davidson tell a familiar story. Labour cost per man certainly did increase to outstrip similar US costs. There has been a slightly offsetting productivity improvement in Canada but not enough to be a basis for disagreeing with the labour cost argument. The US-Canada productivity gap remains of course. Prospects for Canadian tariff reduction were there during the 1965-75 period, but I doubt that these were tangible enough to have much effect until very late in that time. If we accept that the prospects for tariff reductions have encouraged Canada's decline in priority then we must also support the view that direct US investment meant only a wider variety of goods being produced here with the creation of short term jobs and was not the basis for industrial development in Canada that proponents of foreign direct investment would like us to believe. Slow growth in the 1970s, and the other factors listed, all seem pertinent, especially given that the corporate reasons for product transfer to Canada were access to the Canadian market and the Canadian market alone.

Which locations for production have increased attraction for US direct investment? Which countries have displaced Canada? Is the

pattern one of Third World production points being chosen in favour of those in North America? Basically, we can conclude that Canada's rank has slipped among industrial countries and that in the future new investments will be centred in Third World countries. Comparing the two time periods of data that I have mentioned, and which are included in Professor Davidson's paper (Appendix Tables 1 and 3), we find that as a destination for new products, Canada increased in priority relative only to Colombia, Argentina and India; however, Canada declined in the 1965-75 period, compared to the 1945-54 period, by as much as 5.0 per cent against product transfers to Brazil, Spain, Taiwan, South Korea and Ireland, but we can probably group the eight countries named as roughly comparable performers on Davidson's attraction scale. Canada's attractive power declined by 6.0-10 per cent compared with that of the United Kingdom, Mexico, Netherlands, South Africa and the Philippines. The remaining six countries of the twenty listed in Davidson's data were more successful than Canada in attracting new US products. Canada has maintained only 77 per cent of its former position in relation to Japan, West Germany and Italy, while in relation to Australia, France, and Belgium, Canada's comparative priority position has slipped to 87 per cent of its former level. Labour costs or productivity considerations might partly explain the situation, but with distant economies like those of Australia and South Africa, market growth is another factor. Access to the large European Economic Community (EEC) also emerges as an important competitive factor over the 1960s and 1970s. We could argue further that multinational companies of US origin have recognized both the low-risk premium that should be attached to EEC countries and the technological necessity of being located in the expanding, and innovation-active economies of West Germany and Japan.

To conclude, let us look ahead. Tariff reductions are certain to change the marketing and production possibilities of firms in Canada. One effect should be expanded foreign market opportunities for innovative producers in Canada. But who are these producers?

Certainly, it will not be those who rely on inbound technology transfers in the uncreative form with which we are most familiar - direct US investment in secondary manufacturing. This conclusion will hold unless there is greatly expanded product mandating and North American rationalization by the firms referred to in Davidson's paper, which would mean a conversion of the implied process of Canadian de-industrialization (by many US firms in Canada) to one of industrial progress. How likely is such a change by these firms - a change from technology importing to technology exchange through product trade?

DISCUSSION

Davidson: I want to thank you both for your articulate and thoughtful comments. I'd like to make a couple of points. First of all, the issues that Professor Richardson raised about the export cycle and product diffusion are clearly very important aspects of this problem. The export cycle is related to the transfer of the manufacturing technology because the transfer is dictated by market volume. In fact, in all the transfers we've looked at, 95 per cent were primarily put in place to serve a local market. Only 5.0 per cent of all these transfers involved the establishment of an offshore manufacturing site, for example, in Taiwan or the Mexican Border Zone. We are not looking at the issue of offshore manufacturing in a broader sense.

Some of the costs and benefits of direct technology transfer become somewhat easier to separate. The national objectives of any country are going to include five principal objectives: growth, employment, balance of trade, inflation and social equity.

The transfer of manufacturing facilities is beneficial to virtually any country where the secondary effects to which Professor Britton referred are nonexistent. It includes employment, new investment, growth, and balance of trade which compare well to the alternative of importing the product.

The issues that Professor Britton brings up are much more closely related to those of national policy, and he points out a key

area of concern - the "depth" of transfer. Are we really talking about a truncated branch facility, or are we talking about the transfer of a broader range of skills, the ability to develop additional technology? It is quite difficult to capture this in the data, although I did make some distinctions in terms of transfer of assembly plants, transfer of full component manufacture and full manufacturing facilities. The assembly/manufacturing distinction is not an easy one and it varies from product to product. This is an area for further research.

Professor Britton is concerned with the long-term benefits resulting from the transfer of new products to Canada. The issue of looking elsewhere for sources of technology raises some very interesting possibilities. Japan and Western Europe, as sources of technology, have very different transfer patterns. Japanese firms almost invariably use minority joint ventures and they transfer in a much more passive way. If you can acquire similar technology transferred in a passive way, perhaps you're going to have more control over Britton's three key areas of concern: the export performance of branch plants versus domestically-owned plants, the level of innovation of such branch facilities versus domestically-controlled plants, and the vulnerability to events in the home country.

However, we have to think about recipients in the Canadian market when considering technology transfer pacts. Are they capable of receiving European and Japanese technology? The Canadian market is dominated by US subsidiaries who clearly are not going to buy the technology from a Western European and/or Japanese firm if it is available from the parent. I question whether the structure is in place to pursue a strategy which emphasizes the acquisition of technology from European and Japanese firms who would permit greater Canadian control.

Silverman: I have a comment on the benefits that you say come from this type of technology transfer. The Ministry of State for Science

and Technology has conducted some studies on this subject,* and concluded that the so-called invisible inflows of technology through the intra-corporate route are substantial but do not fully substitute for indigenous R&D with regard to resulting benefits. For example, foreign-controlled firms generally export less than Canadian-controlled firms.

Davidson: If the alternative form for serving the Canadian market is exports from the United States, then Canada is clearly in a favourable trade position. On the other hand, you might draw up a licensing agreement with more positive trade benefits than a transfer to a wholly-owned subsidiary.

MacDonald: Surely we're much more ambitious than that. There are some alternatives: specialization, product mandating and rationalization of R&D performed in Canada to address export markets. We should consider the net benefits of continuing to import technology at the expense of an indigenous R&D base.

Has anyone looked at the depth of manufacture when technology is transferred? I maintain that the form of technology transfer to Canada is overwhelmingly balanced in favour of the multinationals based abroad.

Silverman: The transfer of a product mandate may not actually transfer the process. At numerous conferences on technology transfer during the past decade, we have been told that the transfer should consist of the transfer of people and know-how, not just the machine that produces the product. You can produce the product if someone gives you the machine and the process, but that is not the same as having the know-how that actually went into the product. For example, high strength

*Canada, Ministry of Science and Technology, Importation of Invisible Research and Development, 1974-1976, MOSST Background Paper No. 3, 1978, and R&D in Canadian and Foreign-Controlled Manufacturing Firms, MOSST Background paper No. 9, 1979.

composite materials can be manufactured without possessing the underlying know-how.

The decline of technology transfers through the establishment of manufacturing facilities seems to follow the increasing preference of US multinationals to invest in other countries. The pattern of US direct investment in the middle of the three time periods (i.e., 1950, 1960 and 1970), reveals that investment in Canada, compared to some European countries, actually declined. If the investment in Canada is considered as a percentage of that in the UK, West Germany, France, and Canada as a group, then 68 per cent of direct US investment in this group of countries went to Canada in 1950. By 1970 it was 48 per cent. If we held such a conference a decade from now, we would probably find that multinational enterprises had increased their technology transfers to developing countries. We should ask ourselves how that might affect Canada. Perhaps the significant point is not that Canada is receiving less US technology through multinational enterprises, but that future technology transfers to developing countries may increasingly make industries in countries such as ours obsolete.

However, some US subsidiaries which, in the 1955-64 period, were doing no R&D in Canada, have adopted product mandates. Now that they have such mandates they're doing autonomous R&D, and therefore developing their own products.

It is not our objective to simply maximize the type of technology transfer described by Professor Davidson. Whether a company should be first or second, whether it should agonize through all these learning problems and costs of developing its own technology, would depend in part on the industry. Would Northern Telecom still be in business if they were second, an adopter of, or a late adopter of technology, instead of developing it themselves? A recent issue of Business Week (5 May, 1980), included a detailed story about the problems of the US industry versus that of the Japanese and the Swiss in the digital watch business. The Swiss were adopters, they were

second, and in fact were never able to achieve the dominance they had in the manufacture of mechanical watch movements. Although the United States had an early lead in the technology that was necessary to produce the watches, the Japanese are far ahead. The Japanese paid attention to market demand, whereas the US companies that were dominant (like National Semi-conductor) did not. The US is now trying to regain this lead; the Swiss seem to be completely out of the market and are going to rely on making watches for that segment of the market that can pay a very high price for a quality watch.

Macdonald: I wonder if the decrease in investment and importation of technology in Canada, compared to other countries, could be explained by the openness of the Canadian market and the fact that other countries are more effectively closing their markets to direct product importation. Canada has a very high tariff structure in certain areas, but imports more duty-free manufactured goods than the US, Japan and the European Economic Community combined. There are very few non-tariff barriers in Canada. We don't have a "buy Canada" strategy. Witness power transformer sales awarded to a foreign supplier over domestic suppliers. Other countries, particularly France, the UK, Germany and certainly Japan, are willing to lower their tariffs, but for them non-tariff barriers (e.g., national preference in electrical generation equipment) are far more important in maintaining their national markets and controlling imports.

We've benefitted tremendously in Canada from the importation of technology, but there has to be a proper balance between local innovation and importation.

DeBresson: I'd like to come back to some of the issues raised earlier. First of all, product and process technology are so intermingled that it's impossible to distinguish them. The product of one is a process of the other. The distinction between the two can usually only be made when you are talking about custom-made items using general purpose production equipment. In our discussions today, however, we are talk-

ing about larger scale manufacturing production where product and process technology are probably interdependent.

I would like to take exception to the statement by John Britton that there are few opportunities for creative work in the adoption of technology from US multinationals. If the adoption is early and includes adaptation by the people that work in the subsidiary in Canada, there are tremendous creative opportunities available in R&D and in production engineering, for example.

However, we have to distinguish between the learning benefits that accrue to the people who are employed in engineering design and production work, those that accrue to the firm and those that actually accrue to Canada. Also, we must distinguish between the legal-institutional modes of technology transfer and actual know-how. In early adoption there are tremendous opportunities for people. But the procedures of multinationals will determine whether learning benefits will accrue to the country. Government can be effective in influencing these procedures.

Northern Telecom obviously has to be the world first user of a technology if it wants to keep a lead in the market, but there are not that many industries where this is the case. Even in electronics, this is not always true. In 1951 the Japanese came to the original Bell seminar which initiated them to point transition technology, and yet they did not get into manufacturing of semi-conductors until the market really expanded. There are cases where the elevator has to be taken on the ground floor - but in most industries, when you're talking about stable product lines and innovation which does not revolutionize an industry, it can be taken en route. In non-ferrous mining technology, Canada is both a world-first user of technology and an early adopter, but has taken the Japanese approach - better use, improvement, and adaptation.

I would like to refer people to Maximo Halty-Carrere's work,* which examines this "upstream strategy" applicable to most industries trying to build up their existing technological capability. By using different modes of transfer, these industries hope to be able to innovate outright.

Richardson: The distinction between product and process is very important. The auto industry in Canada is an example. For a number of years we have manufactured large US cars with US technology. But we have also imported foreign automobile technology in the form of products. Now, the only cars we can manufacture in this country are American cars. Canadian companies do not have the technical skills to manufacture a Japanese or a British car. We've been importing the product technology of small cars for 10 or 15 years, but we still don't know how to make them. Our technical dependency results from subsidiary branch plant technology transfer. On the other hand, Dale Letts' company, Jarvis Clark, makes some of the most advanced underground mining equipment in the world. Without your manufacturing skills I don't think you'd be able to compete on the level you do. Would I be right?

Letts: Yes.

Britton: Chris DeBresson has taken exception to some of my remarks and I would like to respond. I would like to make three points.

First, I find it strange to hear DeBresson say it is impossible to distinguish product and process innovations when in fact he used the distinction in his own paper. Rather than arguing that the two are impossible to separate, it would be more creative to consider, where it is relevant, the difference between genuine product innovations using existing process technology, process innovations for

* M. Halty-Carrere, Technological Development Strategies for Developing Countries: A Review for Policy Makers, Institute for Research on Public Policy, Montreal, 1979.

existing products, and product innovations using new process technology.

Second, within the innovation process, DeBresson and Davidson focus on the generation of the technology for "significant" new products and on their adoption, after transfer. I think we should be more specific about what is meant by "innovation." It may mean developing new technology for a new product, but also covers the use of existing technology in new ways. In this connection I think we should note that there are important opportunities for Canadian innovation with existing technology, but companies will need to undertake more developmental work that stresses design engineering and marketing. The advantages are many, especially considering that small, even new, domestic firms can undertake this type of innovation as a basic style of operation or as a preliminary to more costly ventures into research, as well as development.

Third, I did not say that there are few opportunities for creative work in the adoption of technology from US multinationals. In fact, I suggested, like DeBresson, that it is possible to transfer product technology in a way that does permit creative use of imported ideas in new products designed here, and I referred to the learning benefits that can be derived by Canadian firms linked with the enterprise receiving the imported technology. I also said that present product transfers through US direct investments are probably accompanied by few realised possibilities for creative pre-production work in Canada. As far as I am concerned these creative possibilities are just that and not a good description of the current industrial reality in Canada.

Rather than looking only at innovative firms or adopters in Canada as DeBresson has done, my concern is with the whole population of Canadian firms. The mass of firms, domestic and foreign subsidiaries alike, just do not innovate or adopt fast enough. Presumably this is because of lack of interest, aggression, ability, capital or man-

date. When reading Davidson's paper it is important to use a larger frame of reference because, like DeBresson, he is concerned only with the firms that produce significant new products. Canada must contend with domestic non-innovators/adopters, and the dominance of foreign non-innovators in the production base.

II. TECHNOLOGY TRANSFER BY LICENSING



**Technology Acquisition:
Licence Agreement or Joint Venture**

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This paper discusses the conditions under which firms wishing to acquire technology might use two types of licence agreements and two types of joint ventures. An examination of 74 licence agreements and 30 joint ventures provides evidence of firms that use each of the four types, and allows some interesting observations about the market for technology.

*This market appears to be small, inconsistent and fragmented. A firm might be offered the same technology in a simple licence agreement from one supplier, while a second demands a 50-50 joint venture. Many technology suppliers will not enter joint ventures in which they own less than 50 per cent, creating a very thin market for joint ventures in which the technology-dependent firm is a majority owner. The implications of these factors, and the way in which technology prices appear to be established, are also discussed. This paper is unusual in that it looks at the market from the viewpoint of the buyer of technology, rather than the seller.**

About 1920 a Swedish chemical firm decided to stop doing its own research and development work and to concentrate instead on searching out the leading chemical process technologies in the world and acquire them under licence or, if the firm with the technology insisted, through the use of joint ventures. In 1974, this company, which had by that time become the largest chemical group in the country, was delighted to learn that its 14 year old, 50 per cent owned polyethylene joint venture was recorded as the most profitable firm (on a percentage basis) in Sweden. The general manager of the venture indicated recently that, in the opinion of all concerned, the company's strategy of acquiring outside technology has been a marked success and will continue.

* Funding for this research was provided by the Fund for Excellence, The University of Western Ontario, The Department of Industry Trade and Commerce (licensing study), and the Foreign Investment Review Agency (joint venture study).

This successful Swedish venture raises a number of questions for managers in any country. The issue is, why go it alone if you can get the help you need on reasonable terms? Managers who buy technology suggest quietly that it is often an underpriced commodity, especially when the package may include marketing assistance, as well as product design and production process specifications. It is, they argue, much less expensive to purchase such information than to learn from one's own mistakes. However, absorbing knowledge from others is not quite so simple as it sounds, the Swedes notwithstanding. Establishing and maintaining a working relationship with a firm which is technically superior to your own requires some specialized skills.

A Prescriptive Model

The first portion of this paper describes a model of the conditions under which technology-deficient firms should and should not make use of current technology licence agreements, current and future technology licence agreements, joint ventures in which they own a strong controlling interest, and joint ventures in which they are approximately or exactly equal owners with the technology supplier. This model is based on a fundamental proposition:

The more the technology-dependent firm needs to learn about the business to which the technology in question relates, the stronger the relationship it needs to form between its personnel and those of the technology supplier.

It is easy enough to transfer hardware - blueprints, specifications, price lists, product samples; but much harder to ensure the transmission of the intangible know-how which is in the minds of the men who use the hardware. Effective transfer of know-how requires a strong personal relationship between sender and receiver, and it is to this fact that the proposition relates. Once the sender begins to know the man to whom he is transferring information, he can tailor his messages, very specifically taking into account that man's knowledge and skills. Conversely, the recipient of the information, as he gets

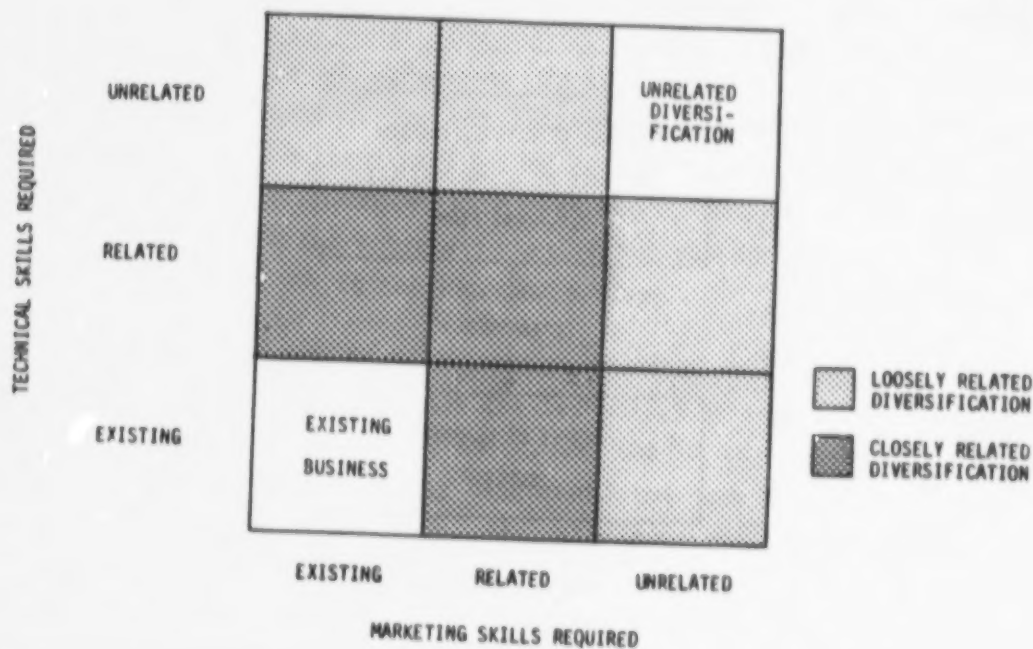
to know the sender better, can realistically assess the information being supplied to him. If the sender indicates, for instance, that an engineering development is likely to take six months, the recipient can assess, with experience, the reliability of this forecast.

The strength of the relationship between sender and receiver is conditional upon the amount of contact between the personnel of the two firms, and the degree of commitment on the part of the technology-supplying firm to ensure that real learning takes place. Both of these factors will be a function of the type of licence agreement or joint venture chosen. Since gaining the commitment of the technology supplier and access to its personnel generally cost money, in one form or another, the objective is to match the strength of the linkage with the task at hand.

The learning needs of the dependent firm will depend on how far it is moving away from its established base of knowledge and skills.¹ If the major areas of learning are technical and concerned with marketing, and each of the skills needed for the product are identical to existing skills, related to existing skills, or unrelated to existing skills, then the following chart of diversification possibilities can be created (See Figure 1).

As the figure suggests, several of these nine categories will be combined to create four strategies of diversification for subsequent analysis. Unrelated diversification means that in neither area is the skill needed for the new product related to skills existing in the firm. Loosely related diversification indicates that either the marketing or the technical skills needed are unrelated to those existing in the firm, but not both. When either or both needed skills are related to those in the firm (and neither is unrelated) the strategy will be one of closely related diversification. The final category, existing business, means that both the needed technical and marketing skills already exist in the firm.

Figure 1 - Relationship Between Existing Skills and Those Required For the New Product



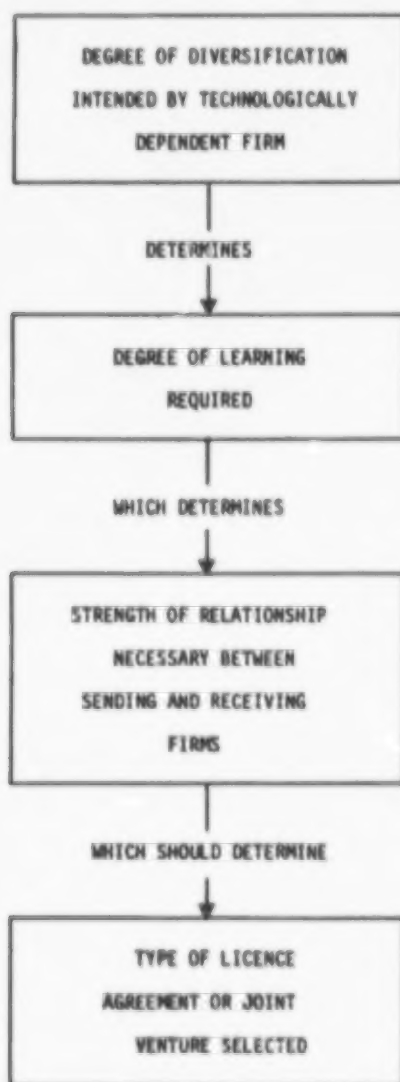
The arguments developed thus far are summarized in Figure 2.

This logic flow will be used to suggest the correct use of two types of licence agreements and two types of joint ventures.

The licence agreements are a) the current technology agreement, which gives the licensee access only to technology which is in existence at the time the licence agreement is signed, and b) the current and future technology agreement, which states that new development work done by the licensor in a specified product area during the life of the agreement, as well as current technology, will be transferred to the licensee. It is apparent that the current and future tech-

nology agreement offers a much greater opportunity for contact between licensor and licensee as meetings between personnel from each firm may

Figure 2 - Logic Flow



take place for a number of years, in comparison with the one-time contact of the current technology agreement. A 1975 study of licence agreements by this author revealed an average yearly contact time between licensor and licensee, in current and future technology agreements, of 45 man days, with a range from 0 to 275.² In a current technology licence agreement, the contact between firms will take place in the first year of the agreement. In such an agreement, the licensor will not assign personnel to the licensee to assist with information transfer, and this happens very seldom even in current and future technology agreements. Licensees have been known, however, to assist the information flow in current and future technology agreements by permanently assigning a man to the licensor's plant.

The two types of joint venture examined in this study are the majority joint venture, in which the technology dependent firm owns 70 per cent or more of the voting stock, and the 50 to 55 per cent joint venture in which the technology dependent firm owns 50 per cent to 55 per cent of the joint company. Generally speaking, there is greater motivation and opportunity for contact between firms in joint ventures than in licence agreements. A 1977 study,³ examining the use of licence agreements and joint ventures by British firms in India, presented data to support this statement. Howard Davies found that 78 per cent of the companies involved in joint ventures made use of personnel from the technology-supplying parent to supervise plant construction, versus 26 per cent involved in licence agreements. In 28 per cent of the joint ventures, managers from the technology supplier joined the venture, whereas this was true for only 5.0 per cent of licence agreements. Transfers of plant level personnel occurred in 48 per cent of the joint ventures, versus 15 per cent of the licence agreements.

Somewhat more detailed data were collected by this author from a sample of 30 joint ventures involving Canadian, American, and Western European firms. Differentiation was made between majority joint ventures and 50 to 55 per cent joint ventures and a distinction

was drawn between employees permanently assigned to the venture by the technology parent, and those on short-term visits or longer-term loans. In contrast to the figures shown below, it should be noted that in only one of the 74 Canadian and British licence agreements which will be referred to subsequently was an employee permanently assigned to the licensee by the licensor.

Table 1 - Personnel Transfers

	<u>Employees from Technology Parent</u>			Total
	Visits Only	On Loan	Permanently Assigned	
Majority Joint Venture	1	2	2	5
50-55% Joint Venture	4	4	17	25
Total	5	6	19	30

The probability of employees being assigned to a joint venture in which the technology supplying parent has 45 to 50 per cent of the equity is clearly greater than in those cases in which it has 30 per cent or less. These are generally production managers and/or engineering managers. The only surprise in Table 1 is the fact that there were as many as four ventures (16 per cent in the category) of which technology parents owned 45 to 50 per cent and to which they did not lend or assign personnel. However, two of these ventures were so small that they had no permanent employees, and were using part-time help from the local parent. A third was performing extremely poorly, and the Canadian manager attributed this poor performance directly to the fact that the foreign parent had not lent them a technical man for the first few years.

The linkage between the last two steps of Figure 2 should now be clear. If a weak relationship with a technology supplier is all that a firm requires, it should try for a current technology licence agreement. As the strength of the required relationship increases, the target should be a current and future technology licence agreement, or a majority joint venture, and in cases where the strongest link is needed, a 50 to 55 per cent joint venture. The cost of the agreement to the technology-dependent firm generally goes up as the strength of the linkage increases. This cost may be reflected in other ways than royalty rates. For instance, current and future technology licence agreements generally have a much higher incidence of export restrictions than do current-technology agreements, and they are also more readily available on older products. The data below are from the 1975 licensing study.

Table 2 - Export Restrictions and Product Age

	Allowed to Export ¹		Product Age ² (years)		
	Yes	No	0-3	4-10	10+
Current Technology	18	6	20	4	3
Current and Future Technology	6	26	5	14	20
Total	24	32	25	18	23

1. The export statistics relate only to products manufactured by Canadian licensees. It is illegal for a licensor to restrict a British Licensee from exporting within the EEC.

2. Product Age is the time in years between a product's first world introduction and its introduction by the licensee.

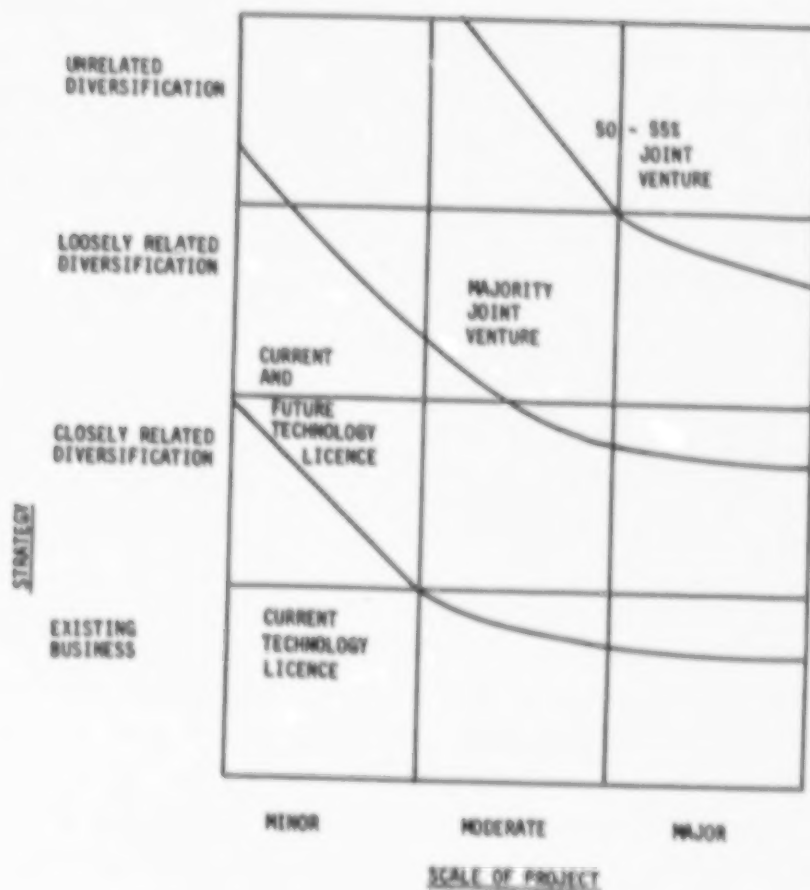
Source: Peter Killing, "Manufacturing Under Licence," Business Quarterly, Winter 1977.

The cost difference between a current and future technology agreement and a majority joint venture is less clear cut. In fact, the president of one Canadian firm using a majority joint venture argued that on a cash flow basis, a majority joint venture could be less expensive than a current and future technology agreement. He reasoned that in giving a technology supplier 20 per cent of the equity of the new venture in exchange for its technology, the cash (dividend payments) going to that parent would only be about 0.5 per cent of sales. He based this calculation on after-tax earnings of approximately 5.0 per cent of sales, and a 50 per cent dividend pay-out ratio. This fee is not only far lower than that of most licence fees, but it is also payable at the discretion of the licensee, and can be withheld until the venture is stable and profitable. Of course, the technology supplier owns 20 per cent of the joint company, and this will eventually be a cost to the Canadian manager.

The high cost which managers attribute to the 50 to 55 per cent joint venture is not strictly a financial one, but includes their high managerial cost. Only with this option does the technology-dependent parent not have clear managerial control of the operation. Major decisions in such a venture have to be made via negotiation and compromise, and the managerial time demanded by a 50 to 55 per cent venture is very high. Many firms will not enter joint ventures of this type.

The model below reflects these arguments and the belief that firms should be more conservative as the financial investment which they are making in their diversification rises. If the diversification involves a small capital outlay, the firm might risk a less strong link with its technology supplier. Thus, in Figure 3, it is recommended that a firm planning a small-scale, closely-related diversification choose a current or current and future technology agreement, whereas a large-scale, closely-related diversification should be implemented via a current and future technology licence or a majority joint venture.

Figure 3 - Prescriptive Model



The boundaries shown in Figure 3 between the four types of agreements are not intended to be exact. They have been constructed on the principle that as a project increases in scale and degree of diversification, the necessary strength of relationship between the parties increases, and the type of agreement specified reflects this. The fol-

lowing sections address the question of whether or not firms actually behave as this model states that they should.

Licensing Practice

With the exception of the fact that some firms are using licence agreements to pursue unrelated diversification, a phenomenon discussed in a moment, data on 74 licence agreements involving Canadian and British licences presented in Table 3 suggest that firms do behave much as the model predicts. As the degree of diversification increases, so does the proportion of current and future technology agreements. In the simplest situations, small and moderate expansions using existing skills, no current and future technology agreements are being used at all. To implement loosely-related diversification, many more firms are using current and future agreements rather than current agreements, and few licence agreements are used at all in projects of any magnitude. The only surprise is that firms are using current technology agreements to effect closely-related diversification.

A close examination was made of the licence agreements used in unrelated diversification situations. In the largest of these projects, the licensees had taken unusual steps to increase the strength of the bond with the licensor. In one case, the licensee stipulated that a senior executive of the licensor must come to work for the Canadian firm for a period of two years, to be replaced by one of his fellow workers when his term expired. This was the only one of the 74 agreements in which such a transaction took place. In the other large unrelated project, the two companies were situated in immediately adjacent cities on either side of the Canada - United States border. Telephone communication between the firms took place, right down to the level of draftsman. Many problems were solved over a downtown lunch. These examples seem to reinforce the underlying principle on which Figure 3 was constructed.

Table 3 - Licensing Data

	Investment (\$000's)			Totals
	50	50-499	500 +	
Unrelated	c=0 c+f=0	c=2 c+f=0	c=0 c+f=2	c=2 c+f=2
Loosely Related	c=1 c+f=28	c=1 c+f=2	c=0 c+f=2	c=2 c+f=32
Closely Related	c=1 c+f=3	c=4 c+f=5	c=7 c+f=2	c=12 c+f=10
Existing Product	c=5 c+f=0	c=6 c+f=0	c=1 c+f=2	c=12 c+f=2
Totals	c=7 c+f=31	c=13 c+f=7	c=8 c+f=8	c=28 c+f=46

Use of Joint Ventures

The 28 samples of joint ventures which were available for examination, Table 4, are fewer than those used to examine licensing practices, but enough to demonstrate conclusively that the model of Figure 3 does not accurately predict the situations in which firms will use the two types of joint ventures in question.⁴ Joint ventures in which the technology-dependent partner held 50 to 55 per cent of the equity were common in situations in which it was predicted that only current and future technology agreements or majority joint ventures would be used. On the other hand, only one firm attempted a large-scale, unrelated diversification using a 50 to 55 per cent joint venture. Another striking observation was that only five of the 28 were majority joint ventures.

Table 4 - Joint Venture Data

	Investment (\$000's)			Totals
	50	50-499	500 +	
Unrelated	0	0	50/55 = 1 MAJ = 0	50/55 = 1 MAJ = 0
Loosely Related	50/55 = 1 MAJ = 0	50/55 = 6 MAJ = 0	50/55 = 3 MAJ = 2	50/55 = 10 MAJ = 2
Closely Related	50/55 = 2 MAJ = 0	50/55 = 4 MAJ = 0	50/55 = 5 MAJ = 2	50/55 = 11 MAJ = 2
Existing Product	0	0	50/55 = 1 MAJ = 1	50/55 = 1 MAJ = 1
Totals	50/55 = 3 MAJ = 0	50/55 = 10 MAJ = 0	50/55 = 10 MAJ = 5	50/55 = 23 MAJ = 5

The underlying cause of both the relatively low use of majority joint ventures and the seemingly inappropriate use of 50 to 55 per cent joint ventures was the same. Many firms with valuable technology will not supply it to a joint venture in which they own less than 50 per cent. The market therefore contains a significant discontinuity. Many technology-seeking firms try to set up joint ventures in which they will be the majority owner, but are offered only 50-50 joint ventures. Faced with no other choice, or perhaps only an opportunity to enter an equally inappropriate licence agreement, firms opt for the 50-50 joint venture. This explains the frequent use of ventures in the 50 to 55 per cent category when less strong linkages are called for.

The Market for Technology

While talking with managers of both technology-dependent firms and technology suppliers, in an effort to understand the results in Table

4, a number of factors emerged about the market for technology. The overwhelming impression is of a small, fragmented, inconsistent market in which both buyers and sellers operate with little information. Several characteristics of this market relevant to managers of firms wishing to buy technology are discussed below.

(i) The High Cost of the Search

The major companies in an industry do not, as a general rule, want to sell their technology. They might sell technology in a fringe area into which they ventured by chance, but they would rather capture for themselves the return on technology from their major businesses. This means they prefer to serve a foreign market through exports or direct foreign investment to the extent that this is feasible considering the economics of the situation and the attitude of the foreign government involved. The implication is that potential technology purchasers will have to look among the smaller firms in the industry, and at firms in different industries, to find willing technology suppliers.⁵ This search process is made more difficult by the fact that many firms with good technology, which they would be willing to sell, do not consider the sale of information to be a particularly lucrative activity, and thus do not advertise their position, or even make it particularly easy for a buyer to negotiate a sale. They have more important things to worry about. The size and nature of the market is therefore determined by the thoroughness and aggressiveness of the potential purchaser. Managers often face the difficult decision of whether to accept the deal they are currently being offered, which does not quite fit their needs, or to keep on with the search.

(ii) Disparate Choices

If a firm is persistent in its search for a technology supplier, it may well end up with several very dissimilar offers. In 1977, a Canadian firm was attempting a loosely-related diversification of moderate scale - a situation which according to Figure 3 would call for a majority joint venture, or possibly a current and future technology agreement.

However, one European firm offered the Canadians a current-technology agreement with a royalty rate of 2.0 to 3.0 per cent of sales, while a second suggested a 50-50 joint venture in which the supplier would provide machinery (rather than cash) as equity, and two executives. Neither choice was ideal, in the Canadians' view; one offered not enough liaison with the technology supplier, and the other too much. However, because the firm felt it needed more help than was available with the current-technology licence agreement, it chose the joint venture. A Canadian competitor subsequently picked up the licence agreement. Two years later, the joint venture was liquidated, a victim in part of the lack of flexibility of having a partner thousands of miles away who needed to be consulted on decisions which had to be made quickly. The competitor with the licence agreement has flourished.

The most difficult choice arises when the quality of the technology varies between two suppliers, as well as the price of the technology and the necessary administrative mechanism (licence agreement or joint venture). One example is a firm with what appears to be the better technology that will only supply it to a 50-50 joint venture, and demands a higher price for it. The firm with the weaker technology is more flexible and offers a lower price. The buyer's indecision is often compounded by the fact that it is not completely confident of its assessment of the relative merits of the two technologies.

(iii) Price is Negotiable

Neither buyers nor sellers of technology seem to have a clear idea of the value of the commodity in which they are trading. A European firm recently asked to be given 40 per cent of the equity of a new North American joint venture to which it was supplying technology. The North American manager was not at all certain what the European technology was worth, but decided to make a counter offer of 15 per cent. The negotiation ended when both sides agreed on a final figure of 20 per cent. This reduction on the part of the technology supplier was very

significant, as this was not a small joint venture. Another example of the uncertainty surrounding the price of technology was provided in the mid-1970s when a major US company was trying to attract partners into a joint venture in which it would supply the technology. The approach of this billion-dollar company was to say: "here is the work we have done over the past 10 years, what do you think it is worth?" At least one new company was astounded by this procedure, observing that if the creator of the technology could not put a value on it, how did they expect outsiders to do so?

Another sign of the confusion in the market is that current and future technology licence agreements, which appear to offer more to the licensee, do not carry higher royalty rates. The following data were collected from British licensees by the author in 1976.

Table 5 - Royalty Rate and Licence Agreement Type

Royalty Rate	Current Technology	Current and Future Technology	Total
less than 2%	2	2	4
2 - 4.9%	6	9	15
5 - 10%	7	18	25
more than 10%	1	1	2
Total	16	30	46

A second test was carried out to see if royalty rates were a function of product age or the uniqueness of the technology. They were not, leading to speculation that royalty rates may be simply a function of negotiating skills of the parties involved.

Implications for Technology Buyers

(i) Develop a Minimum Level of Technical Competence

To venture unprotected into an unstructured market like that described above is foolhardy. To function effectively as a technology buyer, a firm needs a certain technical competence, otherwise it cannot begin to evaluate what is being offered. Once a deal is signed, technical competence will again be useful in sorting out information coming from the technology supplier. All suggestions and technical specifications coming from a firm which may be a significantly different size than one's own, and located in a different country, cannot be accepted uncritically. Many technology purchasers also find that the transfer of technical ideas is much more effective if they have someone on staff who is trained in the relevant discipline and "speaks the same language" as the engineer who is sending information from the supplying firm.

By 1980 the successful Swedish joint venture referred to at the beginning of the paper had built up a staff of 80 technicians and engineers. Their job was to scrutinize the information coming from the United States and to adapt it to best serve the needs of their particular operation. They were so successful that in some years their operating performance was superior to that of the US divisions which were supplying the technology. American visitors became a common sight in the Swedish plant, not only to teach, but also to learn the differences in operating procedure which had increased the Swedes' efficiency.

(ii) Know Your Needs

When shopping in a market as diverse and unpredictable as that for technology, a firm should have a very good idea of just what it needs in the way of help. Is marketing assistance needed, or just production process specifications? What about product design changes in coming years? Can the firm keep up-to-date on its own or will it need continuing help from the technology supplier? As stated above, the firm looking for technology is likely to be offered alternatives with radi-

cally different costs and implications. Unless one is very well aware of a firm's strengths and weaknesses, and in particular its ability to learn with and without help, these choices will be very difficult.

In addition to being able to size up one's own firm, a manager should also be capable of assessing the character of a potential technology supplier. Is the firm accustomed to transmitting its knowledge to others? Is it jealous of its technology or open with it? Will it be easy or difficult for the firm to gain the attention of employees of the technology supplier once the deal is made? Some managers explain that a joint venture, with senior members of the technology supplier on its board, can readily get the attention of division managers and engineers, whereas the same may not be true if the only link between buyer and seller is a licence agreement.

(iii) Consider the 50-50 Joint Venture

In the course of identifying the thirty joint ventures referred to in this study, the researcher interviewed over 100 managers in North America and Western Europe to discuss their experiences with joint ventures. A great many managers, particularly in North America, will not enter new 50-50 joint ventures.⁵ They view such ventures as too ambiguous, too inflexible, and all too likely to end in a stalemate of confusion and disaster. As the data in this paper suggest, however, any firm that wishes to buy technology but arbitrarily decides that it will not enter 50-50 joint ventures is severely restricting its options. Fifty-fifty is as far as many firms with technology will go in allowing their local partner an equity holding.

One reason for the aversion to 50-50 ventures is that the potential difficulties are well known, and the tales of a few spectacular disasters widespread. Less well known are the successes, and the incredible benefits which can accrue to a firm which is in an equal partnership with a world leader in the technology in question. The effort made by the technology supplier in such a situation to ensure that information is properly and completely transferred to the joint

venture is equivalent to that which it would make for a wholly-owned subsidiary. One leading German company spends \$250 000 annually developing technology for, and supplying it to, a 50-50 joint venture in the United States. In addition it has supplied two full-time managers to the venture, carries out training programs for American personnel both in Germany and the US, and, on a monthly basis, sends news of competitors, new product applications, and tests of new products to the joint venture. There are a group of product specialists in Germany who are responsible for monitoring the joint venture's activities with respect to their product. In four years, the venture's sales have doubled to \$80 million. The problems of managing a 50-50 joint venture can be significant, but so can the rewards. Firms seriously interested in buying technology cannot afford a "hands-off" attitude to these ventures.

Summary

Buying technology can be a viable corporate strategy. To use it effectively, a firm must have some minimum level of technical competence. The market is small and fragmented, and the deals which a technology-seeking firm uncovers will be largely the result of its own hard work. Firms with technology that they would be willing to sell seldom advertise the fact. When deciding whether or not to enter a particular deal, a manager should have closely estimated the amount of help he is going to need in the new product area, and should also know the different degrees of access his employees will enjoy to the supplier's personnel under various types of licence agreements and joint ventures. To be successful, a manager needs to know his firm's requirements and have the perseverance to locate a supplier who can meet them.

Many firms with technology will not enter joint ventures in which they own less than 50 per cent of the equity. This means that technology buyers may be faced with situations in which their only options are either a closer relationship with the technology supplier

than they would ideally like, or no deal at all. Firms that wish to seriously pursue a strategy of technology acquisition need to develop the management skills necessary to handle 50-50 joint ventures.

Notes

1. The skills concept of diversification is an outgrowth of the thesis by Leonard Wrigley, "Divisional Autonomy and Diversification," Harvard Business School, unpublished Ph.D. Thesis, 1970. For further elaboration, see Peter Killing, "Diversification Through Licencing," R&D Management, June 1978.
2. Peter Killing, "Manufacturing Under Licence," Business Quarterly, Winter 1977.
3. Howard Davies, "Technology Transfer Through Commercial Transactions," Journal of Industrial Economics, December 1977.
4. The joint venture data were collected as part of an ongoing study on the management of joint ventures. The intended result is a book, Managing Difficult Joint Ventures, for which a 1981 publication is planned.
5. For similar observations, see Piero Telesio, "Licencing Policy in Multinational Enterprises," unpublished Ph.D. Thesis, Harvard University, 1978.

Commentary by Professor C.J. Maule, Department of Economics, Carleton University, Ottawa:

I would like to thank Peter Killing for his paper. I appreciate the fact that he gave us some particular examples of cases that he dealt with during his research. I think it's important to begin by noting that the paper is addressed to managers who are the receivers of the technology or the licence agreement. It addressed what was in their best interests as the recipients of technology. I'd like to divide my comments into two parts: first, the advice given to managers, and second, the policy implications for Canada of the type of information that is provided in his paper. The concepts that I use to approach this problem are somewhat different from the ones that have been used so far, because I look at the problem from the viewpoint of an economist.

When the remark is made that technology is a very peculiar or difficult market to comprehend, that may be because we're dealing with the economics of information. Information is the basic thing that is transferred, and technology is a type of information. What Peter Killing and other people are talking about is proprietary information. Information in general has the characteristics of a public good; once it is in existence, additional users can have access to it without devoting any more resources to its production.

This creates a problem for the owner or supplier of technology (information), namely, how to get a maximum or even an adequate return. The patent system is set up in order to deal with this problem. As a result, it may pay the owner to behave opportunistically and perhaps withhold information that would be of use to the receiver, if there is a way of commercializing that information through other licensing arrangements which may not be known to the receiving firm. The receiver of the information typically wants more than the licensor wishes to provide. Perhaps that's the first thing the manager should be aware of in dealing with these types of technology and licence

agreements. When you come to the box in Figure 2, the logic flow, (p. 76.) and the discussion of the strength of the relationship necessary between sending and receiving firms, it is important to remember that each side may not equally desire a strong relationship.

The supplier may be willing to give complete details concerning the technology transferred, even in the current and the future technology agreement, or he may not. The question then is: what can the buyer do?

It might be useful to go into greater detail about the nature of the transaction, specifically the items under the cost and terms of the agreement which are mentioned in Professor Killing's paper. Does the method in which the return is extracted by the supplier make a difference in how well that information is transferred? Is there a difference between the use of payment procedures such as a lump sum payment or a royalty rate based on production volume, sales, or on time? Does the supplier of the technology come with some sort of management contract? What about the various levels of ownership in a joint venture?

My second problem with this particular discussion is partly conceptual. The term "technology" is used rather loosely. First of all, I conceptualize it as a type of information. But surely there are different types of information involved in technology transfer. Perhaps it would be useful to break down the term "technology" into a number of component parts. One way that the concept has been divided is in terms of production technology and consumption technology. We've been talking to date mainly about production technology - the blueprints, and so forth that are provided. The term consumption technology has been used to describe the manner in which characteristics are given to products and manifested in highly visible ways, such as the promotion of brand names through advertising campaigns, or more subtly through market research, quality control and the use of sophisticated management information systems. Discussion about the

know-how which has to accompany the blueprints is also part of what is included in the term consumption technology.

It may also be useful to look at the sort of marketing arrangement that goes along with the licence. Does it allow the receiver of the information to market the resultant product in a limited region or globally? Does he receive a world or regional product mandate? That is another dimension of the transaction.

The way in which technology was transferred in the case of a developing country such as Algeria should be looked at. The Algerians tried to import technology from abroad under different types of contractual arrangements, and ran into a number of severe problems. In consequence, they altered the terms of the transfer agreements but still had difficulties. The other example, closer to home, (perhaps Mr. MacDonald will comment on this in detail this afternoon) is how Northern Telecom, after the 1956 consent decree in the United States, which changed the relationship between Western Electric and Northern Electric, altered its acquisition and use of technology. I wondered whether there are some examples that we can draw from that particular situation to highlight the issues and problems in transferring technology.

Some of these points obviously have implications for the Canadian economy, but Professor Killing's paper isn't addressed to them. As participants in a Science Council conference, we must raise the question: Which of the alternative techniques of licensing agreements are in Canada's best interests? Does a current or a current and future agreement increase or decrease technological dependency? Which type of equity arrangement is preferable? How is the learning process transmitted? Which type of payment method costs least? What are the competitive implications? If you transfer technology through a patent, so that the government grants a monopoly right for a certain period of time, or if only one company receives a licence for a particular type

of product within Canada, what are the competitive implications that should be examined? The answers given to these questions, from a national interest standpoint, may be quite different from the answers which are in the best interests of managers.

Commentary by Dr. Dennis Demelto, Economic Council of Canada

I found myself very much in agreement with several of Professor Maule's remarks. It's not uncommon in economic modelling exercises to find that the most interesting and constructive issues really relate to the analysis of why the model breaks down, or why the model doesn't confirm our original hypotheses. In the example that Professor Killing gave, one of the inappropriate (unexpected) uses of the current and future technology licensing agreement, given the hypotheses in the model, occurred because of geographical proximity. These kinds of findings, or additional important variables, may have broad implications.

The increasing rapidity with which technology is being transferred today, and the fact that Canada may not be coming out so well, could be related to this geographic issue. Technological advance in the telecommunications area, for example, may have something to do with it. It's easier to transfer technology today because our technology in the communication field is so much better. A foreign subsidiary can now have a direct line into a parent's computer in France, for example, and enjoy almost instantaneous access to all the design programs of its parent. Such situations might help explain the declining position of the Canadian market as a first recipient of foreign (primarily US) technology. Our geographic advantage may be disappearing because of advances in communications. It's no longer as important to be physically close to the person from whom you're receiving the technology.

One thing that disturbed me about Professor Killing's model is that it is prescriptive, written from the viewpoint of the technology recipient. It's not surprising, therefore, that the model doesn't work when applied to joint ventures. The needs of the technology supplier are not the same as the needs of the technology recipient, and it is extremely important to make that distinction. The form, terms and conditions relating to technology transfer agreements are clearly part of a bargaining process between the parties. A model has to recognize that that bargaining issue is the important one. In that

kind of a situation, it may be likely that the desires of the technology supplying firm will prevail, and this is perhaps why the model breaks down with respect to joint ventures. Professor Killing finds that the technology supplying firm just will not supply valuable technology to a joint venture if they are to have less than 50 per cent of the equity.

Professor Killing changes his characterization of technology when he talks about the breakdown of the model - he starts to talk about "valuable" technology rather than the scale and diversification based characterizations that he was previously using, and introduces an element that is not included in the criteria used to construct the model.

I was disappointed that the model didn't go further in one area. Professor Killing points out that in a 50-50 joint venture the technology supplier will go a long way to ensure the successful transfer of technology. Then he adds, "rather like a parent-subsidary transfer." The implication that there is a particularly deep transfer of technology between a parent and subsidiary because of a commitment within the multinational enterprise to see that the transfer succeeds is particularly interesting in light of the earlier discussion. We have noticed in our work at the Economic Council that the amount of technology transfer and transfer of personnel in parent-subsidary joint technology arrangements is enormous. Unless we have some very unintelligent people on the Canadian side of the multinational enterprise, there must be some kind of learning process going on; we ought to treat some of these parent-subsidary relationships in more evolutionary terms than we do. The product mandate issue is also concerned, it's an evolutionary process where the merchandising starts without much technology expertise, but over time expertise develops and the subsidiary finds itself becoming more innovative and less merely adaptive. There's some evidence of that happening in Canada and it

should be taken into consideration in discussions of truncated industries.

The second point I want to make, which both Professors Killing and Davidson raised, is that the literature about why multinationals license is very fruitful, and very relevant to this discussion. In one sense, the joint venture appears to be intermediate between the decision to license and the decision to engage in direct investment.

The importance of Professor Killing's model lies in how you characterize the transaction itself. What characteristics of the technology transfers are so important that they will influence the type of vehicle that you choose to use? Is the technology in question a leading-edge technology? How important is the status of the technology in the portfolio and activities of the technology supplier? Is there competition in the market for the technology or for the products of the technology? Is there a necessity to introduce the technology rapidly into a specific market? Is the size of the firms, or their past experience with different types of transfer vehicles, important? From what Professor Davidson was saying this morning, it clearly is.

In a 1979 study in this area, on multinational enterprises and licensing, Piero Telesio gave some good advice to firms who are looking for technology:

"Prospective licensees probably have little success in obtaining technology from the larger firms in an industry having a low degree of product diversification. They should concentrate their efforts on approaching smaller firms, more highly diversified firms, and firms with less foreign manufacturing experience...

Licensees might find that they cannot obtain access to state-of-the-arts technology in the pharmaceutical, chemical, and electrical industries if they offer no technology in return, or if their R&D program does not promise important innovations."¹

That sounds as if it's very useful advice for prospective joint ventures. In fact, Professor Killing discussed some of these issues this morning; for example, the role of firm size or diversification.

We don't know very much about joint venture activity in Canada from a global viewpoint. In what industries, for example, are they most common, how long do they last, what is the motivation for them? My impression is that joint ventures which are used to transfer technology are not very important in Canada, and are not as important as in US industries. If this is the case, I suspect that the reason is high foreign control of Canadian industry. That is also why we see less licensing in Canada - because alternative organizational forms are in use.

In the Economic Council's survey just completed, we looked at major innovations in five industries during the 1960-1978 period.² We found about 283 major innovations from firms in those industries. Of those innovations, 96 were cases where the technology which was utilized and developed came from outside the firm. In only nine of those 96 cases was the technology obtained by joint venture; in 56 per cent of the cases it was obtained by parent-subsidiary type transfers. Even in those nine joint ventures, four were in the petroleum area where the technology was a spin-off from developmental joint ventures. Because joint ventures were so rare as the source of technology in the five industries that we studied, we don't have enough information to do a separate analysis.

Finally, there is a comprehensive recent study in the United States by Berg and Friedman.³ It offers an enormous amount of information on joint ventures by motivation, by industry, and by characteristic. There is some evidence that joint venture activity has been falling off in the United States since the early 1970s. There's also evidence that joint ventures are quite short-lived in a surprisingly large number of cases. In the chemical industry for example, it was

found that joint ventures tend to die or be transformed into some other organizational form after only a few years of operation.

Another finding of this study was a consensus that joint ventures are only appropriate in unique circumstances. This was stressed in extensive interviews and data analyses. For example, a joint venture commonly occurred when each partner had something to contribute that was unobtainable via the market place. Much of the discussion of the joint ventures in the US paper stressed the role of the small and medium-sized firm as the technology supplier, in contrast to the emphasis in Professor Killing's paper on the small Canadian firm as buyer, seeking to acquire technology through a joint venture.

The Berg and Friedman paper concludes that the speed of market penetration by large firms, combined with know-how developed in the smaller firms, can result in substantial advantages to a joint venture. I would strongly recommend that the American study be read by Canadian firms contemplating joint ventures, because there is a wealth of information and case studies involving small and large firms.

In summary, the main problem with Professor Killing's model is that it ought to be enriched by a better characterization of the joint ventures. I question whether scale and diversification from core skills are the right criteria for judging the appropriate vehicle to acquire technology. The 50-50 joint venture, for example, was suggested for the firm which has no technology or marketing skills (the unrelated diversification case). What can a firm have to offer his partner if it has no particularly relevant skills? Because no obvious quid pro quo exists, that may not be a good situation for a joint venture. American studies have stressed this.

In Economic Council interviews, we asked firms in Canada why they tried to participate in joint ventures. They stressed that either they had the technology but needed the marketing skills (especially abroad), or they had the marketing skills and channels in Canada but

needed the technology. In the Killing model, because it's prescriptive, the case for joint ventures is based on unrelated diversifications. How can a firm enter into joint ventures when it doesn't have any skills? We need to stress the negotiating process between the parties to a greater extent in our models.

Notes

1. Piero Telesio, Technology Licensing and Multinational Enterprises, Praeger, New York, 1979, p. 110.
2. D.P. Demelto, K.J. McMullen and R.M. Wills, Preliminary Report: Innovation and Technological Change in Five Canadian Industries, Discussion Paper No. 176, Ottawa, Economic Council of Canada, 1980.
3. Sanford V. Berg and Philip Friedman "Joint Ventures in American Industry," Mergers and Acquisitions, Summer 1978; Fall 1978; and Winter 1979.

DISCUSSION

Killing: Thank you both for your comments. As there are not many joint ventures in Canada, the question arises, should we be encouraging more of them as an alternative to wholly-owned subsidiaries?

Demelto: Before attempting to answer that question we have to know why we don't have more joint ventures existing in Canada now.

Killing: Many firms are very possessive of their technology, and don't want partners. Increasingly, all a Canadian company has to offer a partner is its nationality. In some of the 50-50 joint ventures I studied, Americans had entered only because they wanted a Canadian partner. Alone, they felt too vulnerable to the Foreign Investment Review Agency (FIRA). The Canadian firm knew nothing about the business in question, and the American firm preferred it that way because it didn't want the Canadian firm involved in their operations, a classic "underdeveloped country" syndrome. Large American companies going into a developing country pick firms that will never learn the technology so that the US partner remains important to that company. This is a deliberate strategy, and because Canada in some respects looks like those developing countries, it is often used here.

With respect to Professor Maule's comment about production versus consumption technology, I've done some work on that issue from the perspective of licensing. In roughly 10 per cent of the licence agreements, the recipient specifically wanted marketing help and didn't

care about production technology. Most of the licensing agreements were a mix of marketing and production technology and there were a few that were production only.

Dr. Demelto commented about a better characterization of joint ventures. I'm now doing a detailed study of joint ventures which will result in a book on how to manage joint ventures more successfully. Some of the largest, most sophisticated companies are losing money in their joint ventures and folding them. I've interviewed managers connected with 40 joint ventures about where they went wrong and why. This is the basis of the book.

Grimley: The National Research Council is active in technology transfer, although not exactly in the same way as a private company. I find that we use the same or analogous means as those described today. For instance, we are in the business of licensing NRC technology to industry, so we have licence agreements to deal with. We are involved in our version of joint ventures through collaborative projects between NRC scientists and engineers and those in industry to transfer NRC technology to industry. We encounter many of the situations that were described earlier.

I have two observations that might lead to additional comments. The first is that, because of the nature of technology, there are many aspects of technology transfer that are unlike information transmission in a lecture room or a library. To a great extent, technology transfer is learning by doing. If the practice of the technology isn't learned well, or the recipient doesn't keep himself adept in its use, the technology can become uncompetitive in relation to other technologies because the user is not proceeding down the learning curve, the experience curve, in a useful way. There is a need for continuing contact between the suppliers of technology and the recipients to develop the latter's adeptness in using the technology in situations that are not always foreseen, particularly when the technology in question is new or "leading edge."

Second, the reputation of the supplier is sometimes at stake, and his concern for the reputation of his technology and his goods may lead him to insist on a close relationship with the recipient. NRC does the same; we insist that the company that we're collaborating with deploys more than a certain minimum amount of resources into the joint activity to ensure that the technology is practiced.

Our general experience is that Canadian companies are quite noticeably hungry for technology. They can define what they would like to have and what they would do with it. The problem is not deciding what kind of transfer arrangement to enter into with a potential supplier, but what corporate resources to put into technology acquisition.

Attitudes on the part of the recipient are obviously a part of the analysis and will have to be taken into account.

John Lockyer: I think there are three obstacles to technology transfer from the US to Canada. Only one has been mentioned in a European context by Professor Killing, a joint venture in which the Board of Directors are far away and inaccessible. But this problem is also apparent in the case of a US subsidiary in Canada whose board members may be very accessible but are probably surrounded by a remarkable arrangement of lawyers and advisers who, because it's a foreign enterprise, immediately have to act if the joint venture wishes to move away from its original direction. This organizational obstacle reduces flexibility as much as a geographical barrier.

The two obstacles that were not mentioned result from US legislation on restraint of trade and export of technology; these obstacles have become more rigorous over the last year or so. Both restraints affect the joint ventures; licensing agreements are affected primarily by legislation on the export of technology.

For a Canadian company, Canadian law provides a reasonably flexible approach to monopoly and the restraint of trade; the US law is more restrictive about restraint of trade. In joint ventures, US companies are bound by their own legislation.

Sorting out these legislative requirements takes time. When a licence is finally obtained from the State Department to export the technology, the competition may be off and running.

MacDonald: Some kinds of agreements may involve very little actual technology transfer. Patent licences, which involve rights to certain patents only, may be undertaken to preserve future market freedom. Other transfers occur in which technology is very freely exchanged. A company may be under some legal obligation or other pressure to exchange a technology which might result in a one-shot transfer, but generally, when two companies enter into a technology exchange, they enter into it with reasonable freedom. It's in the interest of both sides, and particularly in the interest of the transferee, for the exchange to succeed. Therefore, he puts a lot of effort into it.

I suspect that Canada is in a very poor bargaining position to encourage joint ventures. Consider a generalized market strategy: the first priority of a company is to sell directly into the market; but if they are restricted from doing that successfully by tariff or other barriers, their next option might be to manufacture locally. They invest in the country. The third option might be to enter into a joint venture, but only as a result of some restrictions on other arrangements. The fourth option might be to license. If this generalized scenario is correct, there is very little incentive in Canada, except tariffs, to undertake a joint venture or to license. When someone in Canada does enter licensing or joint venture arrangement, the licensor's marketing restrictions would probably be severe.

A great deal of technology transfer also takes place through acquisition. In the US, this may be the dominant mode of transfer.

Another factor in technology transfer is the rate of technological change. Joint ventures, especially where high-technology is involved, should decrease in the future. In the time it takes to establish a joint venture the technology might lose its value.

III. TECHNOLOGY TRANSFER BY MULTINATIONALS AND BY LICENSING:
THE EXPERIENCE OF THREE FIRMS

Technology Transfer Within A Multinational:
The Case of Westinghouse Canada Ltd.

J.K. Carman
Vice-President
Westinghouse Canada Ltd.

As a native-born Canadian and an employee of a multinational, I am interested in hearing ongoing^d debates on the Canadian economy. Over the past couple of years, Don Pollock and I worked closely trying to solve some of the ills of the electrical/electronic sector of Canadian manufacturing. In connection with this, I would like to discuss some of the corporate strategies that Westinghouse Canada has designed to meet changing conditions in the Canadian electrical products market. I strongly believe that the strategies we've adopted are best for Canada. If you think that's too broad a statement, at least they're best for Westinghouse in both domestic and foreign markets. This is true despite the fact that Westinghouse is in an industrial sector dominated by foreign ownership where branch plant operations outnumber all others.

Our strategies at Westinghouse are externally oriented and focus on what we call the "economies of specialization." John MacDonald of Northern Telecom may talk about "economies of scale," but this is the other alternative. We believe that we can increase productivity from economies of specialization. We also think that successful implementation of our strategic plans will require, and will result in, increased Canadian research and development.

The fact is, however, that the primary objective of all of Canadian manufacturing must be a reversal of that worsening trend in the balance of payments of manufactured end products. It rose from \$12 billion to \$17 billion in 1978-79, and of this about \$3 billion is in the electrical/electronic sector. An approach like ours, adopted nationally, might help to reverse that trend.

During the past year at Westinghouse we have studied the relationship between profits, exports and technology. Our survey covered over 20 subsidiaries of foreign parents. We found that subsidiaries who export are more profitable than those who operate in the branch plant mode alone. Our definition of branch plant is one that serves only the domestic market with goods and services which are often

made more cost-effectively elsewhere in the organization, or even by other local competitors.

Second, subsidiaries responsible for world product mandates have a stronger technology base. Subsidiaries in the electrical/electronic sector which export a product from a Canadian base usually have some form of technology control or technology base in the product they export. We believe that subsidiaries which operate solely in a branch plant mode have a low probability of survival in the post-GATT world of 1989.

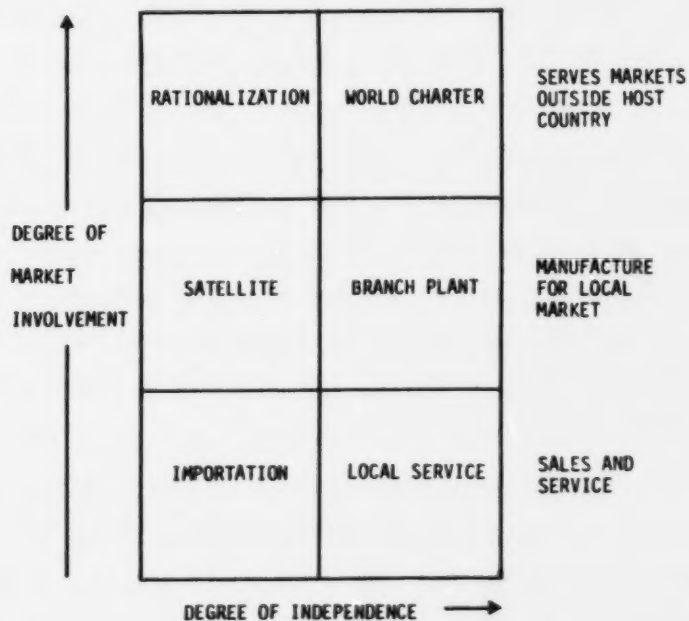
I am going to discuss Westinghouse's experience in the transfer and use of foreign technology and its relationship to our world product mandate strategy. This will involve a review of four areas: vital statistics (who we are and what the numbers reveal about Westinghouse); approach to portfolio analysis; our key strategies; and the transfer and development of the technology required to support those strategies.

Our sales are \$500 million a year. We employ about 7300 people across Canada in about 100 locations. There are sixteen factories and manufacturing plants, and more small plants are under construction. In addition, we have 30 service centres and 50 sales offices. We export about 20 per cent of our sales, and we serve the construction, industrial, and utility markets. We no longer manufacture appliances.

When Canada developed its first industrial strategy by establishing high tariff laws, foreign based companies entered this country in a very predictable way - by importing. Market share problems and cost pressures led to changes, first to satellite assembly (simple "screwdriver" assembly), and a minimum investment facility, then to branch plant manufacturing for the Canadian market only. This pattern, of course, is not unique to Westinghouse in Canada or even just to Canada; it is common to any country that's developing an industrial base.

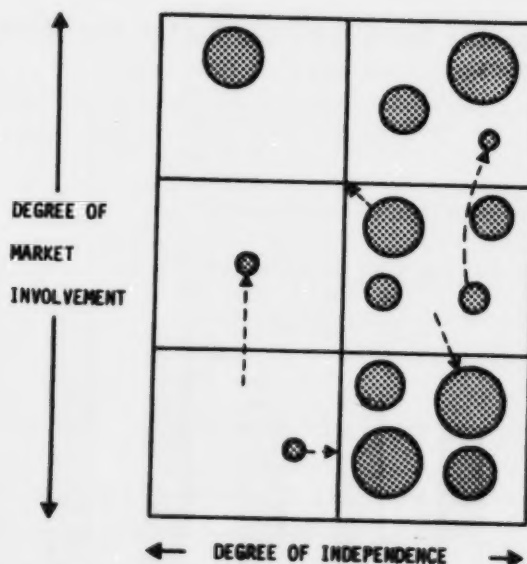
Figure 1 shows our approach to portfolio analysis and the way we service that portfolio with technology.

Figure 1 - Portfolio Analysis



As a country matures, so does its industrial base, until a point is reached where survival dictates an export strategy. A multinational reaches a point where it stops trying to serve only the domestic market. It reduces the number of subsidiary manufactured products through rationalization and assigns world product mandates to the subsidiary. In Canada, we believe that Westinghouse, along with firms in other industrial sectors, is at that point now.

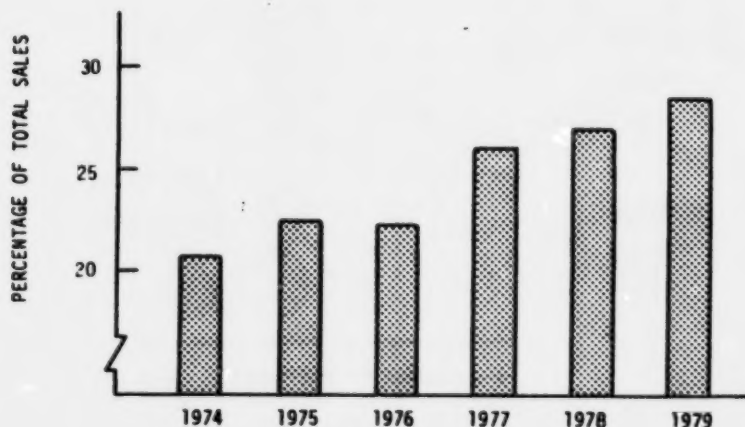
Figure 2 - Corporate Product Strategy



We put our businesses on a grid (Figure 2) last year. At that time, 25 per cent of our current sales came from two key categories. The middle right-hand section of the grid is the branch plant section. The core element in our strategy is to move businesses from that branch plant category either into the North American rationalized section (top left), into the world product mandate section (top right), or down into local service (bottom right). All these areas are of more importance to Canada than the branch plant strategy. For example, as you move from importation to local service you become more independent of the parent firm. Now, 28.5 per cent of our current sales come from product mandates and rationalization. This is important, because our technology base must be strongest here in order to be internationally competitive. Figure 3 shows that, as a percentage of sales volume, the world product mandate and North American rationalization added together

over the last five years have grown from 20 per cent to about 28 per cent.

Figure 3 - Products for the North American Market and Those With World Mandates



Another way to look at this might be to put our products into three categories:

1. products based on our parent's technology and dependent on a continuing flow of foreign technical information. The only changes made are product modifications to satisfy the Canadian Standards Association or other local needs;
2. products where WEC technology was initially transferred to Canada, and then, to satisfy market or customer needs, a Canadian product development program was started - out of this came a uniquely Canadian product;
3. products developed using Canadian engineers and technology where world product mandates have also resulted.

Table 1 - Products Based on W.E.C. (Imported) Technology

- . medium a.c. motors
 - . general purpose control
 - . moulded case circuit breakers
 - . high voltage and panel control
 - . motor control centres
 - . metalclad switchgear
 - . meters
 - . relays
 - . distribution transformers
 - . capacitors
 - . distribution protective equipment
 - . outdoor lighting
 - . air conditioning
 - . lamps
 - . bus duct
-

Table 1 lists products that are fully dependent on US technology. For these, there probably is no rationalized approach or world product mandate in the offing.

Table 2 - Products Based on W.E.C. Technology and Canadian Development

- . large a.c. motors
 - . emergency transfer switches
 - . small steam turbines
 - . power transformers - medium size
 - . network protectors
 - . gas turbines
 - . interior lighting
 - . airport lighting
 - . electric lighting
-

Table 2 lists products for which technology was transferred. Instead of developing a product ourselves, we imported technology from our parent firms and employed Canadian engineers to develop the product

further. Gas turbines, discussed later, are an excellent example of a world product mandate based on this type of technology transfer.

Table 3 - Products based on Canadian Technology

- . panelboards
 - . large core form transformers
 - . automatic controllers
 - . electronic display products
 - . electronic line tracing equipment
 - . electronic defence products
 - . nuclear fuel
 - . nuclear system components
-

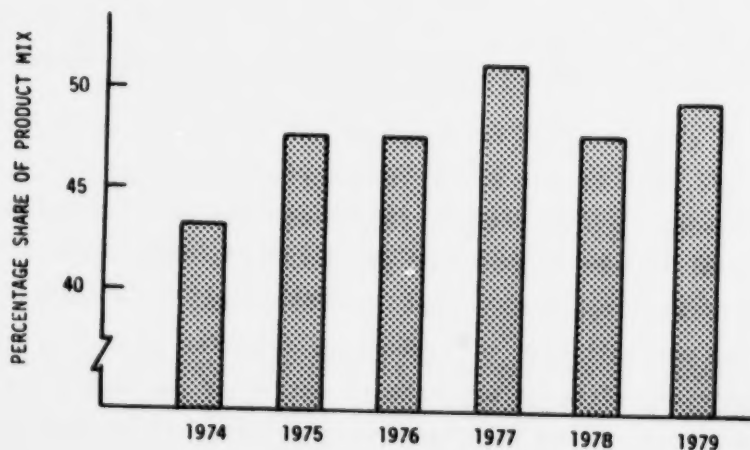
Table 3 lists products for which technology development took place solely within Westinghouse Canada.

Figure 4 shows a five-year sales trend of categories two and three, the two categories we're trying to strengthen. This strengthening process will not take place fast enough for us to implement our strategic plans unless we continue to utilize foreign technology as a starting point. The trend is not steadily improving for a number of reasons, but right now about 50 per cent of our manufactured product sales come from these two categories. The \$500 million in sales I mentioned earlier is not all manufactured product; sales from these two product categories might amount to between \$150 and \$200 million.

The gas turbine example is a success story in the transfer of foreign technology. Gas turbines are now a \$60 million business for Westinghouse Canada and 85 per cent of sales are exports. There were four milestones in the growth of this business. In 1970, Westinghouse Electric Corporation sold \$4.5 million worth of pump motors to Ontario Hydro. A key element in capturing this order was a sub-contract to Westinghouse Canada for the manufacture of turbine parts. That was a straight "build to print exercise" (drawings and specs were supplied;

there was no engineering input, we simply manufactured to the parent's information). It acted as a partial offset to placement of this order in the United States. As we established a capability to manufacture turbines, and our parent firm concentrated on newer and larger turbines, an opportunity arose for us to assume the application, engineering, manufacturing and marketing responsibility for a smaller, older gas turbine with international market potential. Based on our expertise here, we established an application capability, and in partnership with the Canadian government, secured the opportunity to develop two new industrial gas and steam turbines for mechanical drive applications. We obtained a world product mandate for this product family. This assignment also resulted in sub-contracting some key research and development to McMaster University and the National Research Council. It was a true partnership. Currently, the manufacture of these industrial turbines is expanding, with the establishment of a \$30 million,

Figure 4 - Products Wholly or Partly Based on Canadian Technology



highly sophisticated machining facility in Renfrew, Ontario, again with the assistance of our Canadian and Ontario government partners.

In a technology transfer sense, what really happened here? First, the manufacturing technology required to efficiently manufacture turbine parts was transferred in the form of drawings, information, and training. Next, product production and test technology were transferred so that a Canadian design and application capability could be established to accompany the manufacturing capability. Third, based on the assignment of a product mandate to Canada by the parent, and financial assistance from the federal government, a development capability was established and a unique technology generated that resulted in a new family of turbines. In order to remain internationally competitive, we've combined the results of studies in production technology by W.E.C. with our own studies to plan a sophisticated machining facility at Renfrew. That is a pattern we want to repeat. I believe it is the best way for Canada to rapidly reach internationally competitive levels of R&D spending - and, more important, to stay competitive by introducing modern production technology.

Of course, we must also continue to develop original technology, but in our industry, this alone will not be fast enough to provide the technology base needed to compete in international markets.

A crucial goal in Westinghouse Canada's future plans is to reach 50 per cent of our sales in exported products. A key to those exports is some form of product technology control. In our search for international market niches, we are bound to find desirable product areas where Westinghouse is not now involved. We will, therefore, examine the possibilities of technology transfer from manufacturers in other countries, although with the exception of our defence electronics operations, most of the Westinghouse experience in technology transfer has been with our parent, and will probably continue that way. Technology transfer will be a major factor in building up the technology base needed to support our long term strategies.

The government also plays a role in the process of technology transfer. I think that the company I work for is a good Canadian corporate citizen. If the objective is to build a Canadian technology base that makes Canada internationally competitive, then government should not restrict the flow of technology, because this can only result in a faster erosion of the Canadian technology base than that which has occurred over the past fifteen years. The electrical/electronic sector of Canadian industry is 65 to 70 per cent foreign owned; some form of technical licence exists between the Canadian subsidiary and the parent in most cases. Some of these parents operate their subsidiaries purely in a branch plant mode and the technology transfer often contributes very little to the Canadian base. On the other hand, technology transfer that results in eventual Canadian control, as in the Westinghouse turbine example, enhances the Canadian base.

In my opinion, governments could play a very positive role by encouraging technology transfers through the assignment of world product mandates to Canadian subsidiaries. An American businessman once said to me that multinationals are predators who range the world looking for a comfortable nest. A host country must establish the proper bait and when the multinational takes it, trap them, committing them to the country for the long term. Government's role should be to encourage the flow of technology that supports world product mandates. This might take a number of forms - for example, requiring that the technology generated cannot be exported for a long period of time. Such a requirement was a key factor in gas turbines. Funds were advanced for development with the agreement that technology generated would be "trapped" for eight years.

Lowered tax rates on profits from exports by Canadian subsidiaries to all foreign customers other than the parent company would also encourage world product mandate assignments.

Increased tax credits for an expanded definition of Canadian research and development covering both scientific R&D definitions and

manufacturing process development might also help. Productivity is a problem in our industry and we need to concentrate on manufacturing process development.

These suggestions would strengthen the electrical/electronics sector in many ways. More Canadians would be working on technology development, and if the number of exportable products with a strong Canadian technology base was increased, the negative trade balance would decrease. Government might monitor the financial and corporate performance of the company, not the degree of foreign ownership. Utilize the strengths of multinationals in a positive way, rather than attempting to build up Canadian-owned companies at the expense of multinationals.

**Technology Transfer Through Licensing:
The Experience of a Small Canadian-Owned Chemical Company**

Dr. J. Blachford
President
H.L. Blachford Ltd.

H.L. Blachford started as a sales agency many years ago, but we now manufacture everything we sell. We make only industrial chemicals. Our export sales are very small and we sell almost nothing to the federal, provincial or municipal governments. Our sales last year were \$12 million which represents about a 30 per cent increase over the preceeding year. So far this year our sales are up by 31 per cent. Our profits were up by about 100 per cent last year, and this year they're up by about 89 per cent.

We are largely in the chemical specialty business, rather than the specialty chemical business or the commodity chemical business. Specialty chemicals are made by chemically reacting two or more materials to produce one fairly pure material, whereas chemical specialties are generally made by simply mixing several different materials. Chemical specialties are technology intensive and perhaps should be classified as "high-technology."

Here are some examples:

- additives for plastics such as heat stabilizers and lubricants for PVC;
- products that are used in processing rubber, such as process aids and lubricants;
- additives for concrete, products for oil wells such as defoamers and thickeners;
- lubricants used in metal working.

None of these products or product groups can be considered a commodity or even a specialty chemical.

We also have an American subsidiary with sales of about \$7 million a year. This subsidiary manufactures and sells noise control materials such as sound barriers, sound absorbers, and vibration damping compounds. Technology transfer between us occurs freely with damping made by either company. In Canada we have about 500 products and

500 customers. Many of these customers buy several of our products. We try to maintain a high percentage of market share and, at the same time, to sell only to larger customers. We sell particular specialties that require the provision of technical service.

Our manufacturing equipment is versatile, and can make numerous products. Production scale is not particularly important. In many cases we are the sole Canadian manufacturer of a product, in others we have competition from other Canadian manufacturers.

Basically, we have four product lines:

- a) Lubricants that are used in metal working - these are sold to companies manufacturing wire, steel, sheet and powdered metals.
- b) Additives for rubber and plastics - heat stabilizers and lubricants are sold to companies manufacturing or fabricating plastics, especially those companies which make products based on PVC. Lubricants and process aids are sold to the rubber companies.
- c) Acoustical products - we sell to the original equipment manufacturing market; for example, companies making and assembling trucks, buses, tractors, railway and subway cars.
- d) Construction materials - we sell special grouts, mortars and flooring compounds which are used for industrial applications involving corrosive environments. These products are used in steel mills, pulp and paper mills, breweries, dairies, chemical plants, and textile mills.

In short, we are diversified both in markets and products. Providing good technical service to customers is probably our major strength, since our American competitors do not provide as good technical service and our offshore competitors are unable to. High tariff barriers, high non-tariff barriers and high transportation costs protect us less than good technical service.

Research and Development in Our Firm

Almost all the formulations that we receive from licensors, especially Europeans, have to be modified to suit the requirements of our Canadian customers. We frequently have to modify formulations and provide "prescription products" to meet the needs of specific customers. We are particularly interested in developing new products which arise because of "market pull" rather than "technology push." The R&D work we do does not require costly lab equipment, and it is not expensive to move a product from the lab to the plant.

Whether or not we can obtain a government grant has little influence on our decision to work on a proposed project. We have received three Industrial Research Assistance Program (IRAP) grants, and, of course, the money has been a help to us. However, for various reasons, we much prefer tax incentives to grants for encouraging R&D.

Our Experience with Technology Transfer

Approximately 40 per cent of our sales volume comes from products made under licence. We have three major licence agreements: metal working lubricants, acoustical products and construction materials. Two of these were obtained in the US and the third in Germany.

None of our licence agreements involve patent rights. The chemical specialty business is not a fertile patent ground, as it is very easy to get around a patented composition in this field.

We have the exclusive right to trademarks that our licensors have registered in Canada, and our licence agreements grant us exclusivity in the manufacture and sale of certain of the licensors' products in Canada.

Our agreements are of the "evergreen" variety; as long as we fulfill our obligations, the licensor must renew the agreement after the term expires. Therefore, we cannot be considered a captive of

foreign firms who could sell us technology for only as long as it pleased them.

The licensor owns the rights to any improvements we make in the products and we are obliged to inform them of improvements. I believe this violates the US anti-trust laws. The licensor, however, is obliged to inform us of all his revisions in formulations, and of all new formulations and new products. Our agreements, in short, are for "current and future" technology.

We want to be the first licensee to receive a formulation, because every product has a limited life-cycle. We avoid products which are past their peak in profitability.

Royalties are a fixed percentage of the volume of goods sold. If sales are below a certain figure, however, we pay a minimum royalty. In two cases the royalty payment is 5.0 per cent of sales, and in the other it is 2.5 per cent. In one of our agreements there is a high minimum royalty, which increases annually by an amount approximately equal to the percentage increase in the Canadian GNP.

It is very important for us to be skilled in obtaining technical and marketing information from a licensor. Unfortunately, many R&D people are reluctant to be dependent in any way on an outside source, the "not invented here" syndrome.

We have a basic strategy regarding licensing and I think it works. We find a competent firm, negotiate the best agreement that we can, and then, after establishing ourselves in the market, try to develop other products based on similar or closely related technology which is sold to the same or similar markets. Our growth in the last couple of years has resulted mostly from products that we have developed on our own. For example, in acoustical materials our licence agreement only covers sound barriers and vibration damping compounds, but on our own we have developed new sound absorbers. At one time we

had a licence agreement which covered only certain specific heat stabilizers for polyvinyl chloride (PVC). We developed other types of stabilizers not covered by the agreement, and we also developed special lubricants which are used when extruding PVC pipe and conduit. In construction materials our agreement covers products based on certain resins, but does not cover products based on epoxies or on urethanes, and these we have created on our own. In metal working compounds, our agreement covers rolling oils, cutting and grinding compounds, drawing compounds, and corrosion inhibitors; it does not cover the wire drawing lubricants or lubricants for powdered metals, which we have produced independently.

Japanese companies have used a somewhat similar approach and I wonder if the Japanese government has encouraged this.

Why do we enter licence agreements, rather than develop everything on our own? The obvious answer is that it is far cheaper to license technology and marketing know-how if you are starting from scratch in both areas. This is especially true in the small Canadian market. It costs just as much to develop a product for the Canadian market as it does for the American. No company should duplicate technology if it can be acquired at a reasonable price. A licence agreement with a foreign company also excludes that company from competing in the Canadian market.

What about the future? We do not license the manufacture of any of our own products but are looking into it; we are also very weak in export sales but plan to strengthen our position - we must do both if we are to realize a truly satisfactory return on the large amount of money we have invested in R&D.

Technology Transfer and Government Support of R&D

Instead of encouraging companies in general to do more R&D, the government should support particular companies and industries which do a

great deal of R&D and are highly dependent upon it, because companies already highly dependent on R&D tend to be more profitable, and to have better prospects for growth. A 1978 paper by the Ministry of State for Science and Technology* compared R&D intensive industries with less R&D intensive ones in Canada, and found that over a 14 year period, the former showed a 50 per cent higher growth in employment, a 24 per cent higher growth in output, a 29 per cent higher growth in productivity and a 55 per cent lower growth in prices.

I am in favour of Canada possessing greater technological sovereignty. We would then be less vulnerable to what happens elsewhere in the world when countries impose controls on technology transfer. There is a chance that the US and perhaps other countries may pass laws restricting the export of technology.

It has become increasingly difficult to find foreign companies willing to undertake licence agreements with Canadian companies. A few years ago, many companies were keen to conclude them but now they want to enter joint ventures with Canadian firms, to export into Canada, or to find Canadian companies who will manufacture their products on a toll basis. Policy makers should investigate this trend.

The restrictions of US anti-trust laws may have increased the reluctance of American firms to make licence agreements, because such laws help a foreign licensee and hinder an American licensor. Their effects should be studied.

The reluctance of foreign companies to conclude licence agreements would increase if the Canadian government placed restrictions on the nature of the licence agreements negotiable by Canadian firms. I can imagine someone suggesting that to help Canadian firms, the government should impose restrictions on, for example, the minimum royalty that the foreign firm could impose on the prospective licensee.

* First Ministers' Conference on the Economy, Ottawa, 27-29 November 1978 "Industrial Research and Development," MOSST paper no. 800-9/012.

Such restrictions would simply encourage the foreign firm to establish a plant of its own in Canada or to export to Canada. The Canadian government would not promote the growth of R&D intensive firms in Canada by imposing restrictions and controls on the transfer of technology. Our small market for manufactured goods calls for a policy of unrestricted technology transfer.

There is a danger in overemphasizing the importance of technology transfer rather than examining the whole matter of what might be called "innovation transfer." A licence agreement might be very helpful and thorough in providing what is required from engineering, manufacturing, and quality control standpoints, but in many cases information and know-how regarding such matters as distribution, marketing strategy, selling and technical service are just as valuable.

How often should the Canadian government encourage companies to become licensors? Frequently. Because of high tariff barriers, it is impossible for a Canadian company to export a product it has developed to the United States. Generally, its only alternative, apart from establishing a subsidiary or forming a joint venture in the US, is to enter a licence agreement with an American company.

There should be close cooperation between government and industry, which can only exist if government and industry trust one another. Any sense that the aims of government and industry are similar is certainly diminished when, as has happened, the government suddenly and without prior consultation presented Bill C-12, an Act to Amend the Corporations and Labour Unions Returns Act. Sub-section 4.2 requires all companies to report in great detail on technology transfers into Canada. Why does the government want this information? How can industry be sure that the government will interpret the information correctly? What action might the government take as a result of their interpretation? By introducing this Bill in such a high-handed manner the government has aroused industry's suspicions. The Science Council may be able to allay industry's fears and foster an attitude of trust and cooperation between industry and government.

Canadian Innovation: A National Imperative

**J.D. Macdonald
Vice-President, Technology Management
Northern Telecom Limited**

Northern Telecom has significant experience in importing technology, but it is rather out of date now. In the early 1960s, about 6.0 per cent of our sales were from products we developed ourselves, but by 1979 these represented approximately 75 per cent of sales.

In this paper, I want to discuss the evils that have visited Canada because Canadians have relied so heavily on imported technology. I am not against importing technology; it's the amount of it in Canada that I oppose. Canadians need to develop a strategy to promote an indigenous technology.

Northern Telecom is in the telecommunications market, with sales of about \$1.9 billion. Less than half those sales are in Canada. Our R&D budget this year (1980) is approximately \$165 million, or about 7.0 per cent of sales. We intend to enter the "office of the future" market area, and we are making a heavy R&D investment to accomplish this goal.

You are all familiar with the story of the emperor's new clothes. The emperor had a suit of clothes which, it was said, was invisible to anyone who was not both honest and wise. Of course, everyone, on seeing the emperor shouted, "Oh, how beautiful. What rich colors!"

But at last, as the emperor was parading through the streets of the city in his great procession, a voice shouted out from the crowd, "But the emperor has nothing on!"

For too long, Canada has been parading in the streets of the world as an industrial nation that ranks among the best. The naked truth, if you will, is that Canada is sadly lacking in indigenous technology and does not have the economic structure of an industrialized nation. Rather than recommending new ways to import technology, I am going to suggest in the next fifteen minutes that we must increase Canadian technological innovation and sharply decrease our dependency

upon imported technology. Otherwise, Canada will not survive as an industrial nation in the years to come.

The extent of Canada's present technological reliance on foreign sources is staggering. The unusually high degree of foreign-controlled Canadian firms makes Canada highly reliant on imported technology. Recent statistics indicate that fully 80 per cent of all technology employed in Canada is imported. In the machine and transportation industries, 95 per cent of R&D is imported, in metal products industries, 91 per cent; and electrical and electronics industries, 56 per cent. Each year approximately \$200 million in payments for patents, industrial designs, royalties and scientific research services is spent on imported technology. In addition, Canada imports \$600-700 million annually in invisible technology in the form of research costs passed on by parent firms to Canadian subsidiaries. For foreign-owned Canadian firms, these costs are more than double those of indigenous R&D.

The same imbalance is evident in the patents issued in Canada. Of the nearly 250 000 patents granted in Canada over the past ten years, less than 6.0 per cent, or one in 18, was granted to a Canadian. Indeed, more patent applications are now filed by Canadians in the US than in Canada. A recent Statistics Canada survey shows that patent filings by non-residents are more prevalent in Canada than in any other major industrial country.

Well, you might say, don't these figures in fact make a case for importing technology? Don't they show how readily available foreign discoveries are? Why should we bother spending our own money on R&D when we can profit from the research done around the world? Such an argument has been frequently made, but unfortunately, it is shortsighted.

Indigenous R&D is the key to a healthy industrial base. To begin with, although imported technology accounts for the major part of

the technological R&D base for Canadian industries, it does not reflect a sufficient level of commitment to Canada's technological future. We are still going to need an indigenous R&D base that is two or even three times its present size to bring Canada up to par with other industrial nations. The most recent figures available indicate that even including "invisible R&D," Canada's total R&D base is only 1.37 per cent of GNP, compared with figures for purely domestic research amounting to 2.35 per cent of GNP in the US, 2.16 per cent in West Germany, 2.0 per cent in Japan, and 1.86 per cent in France.

Looked at from another angle, only 2.7 per cent of Canadian manufacturing firms have any intramural R&D. And for those few firms with intramural R&D, the median-sized research unit is two scientists and engineers.

This reliance on foreign technology creates a vicious cycle of dependency. Without indigenous research facilities our best young minds either choose not to go into technical fields or leave the country, creating a "brain drain" that exacerbates our already poor competitive position. This lack of opportunities is pitiful, considering that we have such a well-educated population - Canada is second after the US in degrees earned per 100 000 population.

Those who advocate the importation of technology as a shortcut to industrial development are taking a naive view of world trade and competition. Countries will license or sell technology only when it serves their best interests, not necessarily when Canada desires it. The steady decline in Canada's share of its own domestic market in high-technology areas shows that foreign countries are finding it easier to sell us their products than to have us manufacture our own. Between 1964 and 1976 the percentage of the Canadian market for consumer electronics served by imports sharply increased from 14 per cent to almost 63 per cent. In computers and office equipment, imports moved from 56 per cent to about 90 per cent of domestic needs during the same

period. And in the general machinery category between 1964 and 1976 the import ratio rose from 65 per cent to 74 per cent.

This dependence on foreign technology and the low overall level of R&D have had onerous consequences. During the past 30 years, Canada has experienced an ever-widening deficit in the trade of manufactured goods, and a still more rapidly growing imbalance in high-technology products. Between 1950 and 1970, Canada's deficit in high-technology products rose from about \$1 billion to about \$2 billion, and between 1970 and 1977 the deficit sharply increased from \$2 billion to \$7.5 billion.

Largely because of its failure to provide innovative technology, Canada's share of the global export market for manufactured goods has also slipped. Our country's portion was 5.9 per cent in 1967 and fell to 4.6 per cent in 1977. This decline represents a loss in export revenue of approximately \$6.5 billion to Canada. The compensating growth has gone largely to the much more determined Japanese, West Germans, French, and Italians, who have moved aggressively into high-technology world markets.

Canada now is at a crossroads. It can make a transition toward true industrial status or it can continue its dependence on foreign technology and regress to a semi-industrial status.

Northern Telecom's development of digital technology during the past decade provides one illustration of how we might choose the forward direction.

Early in the 1970s Northern Telecom was attempting to compete in the US telecommunications market, using analog-based products. Everyone knew that digital technology would one day be applied in telecommunications. NT seized this opportunity and made the R&D investment. We had to gamble that the digital technology would be more cost-effective than the older analog technology. The timing was critical.

And we had to believe sufficiently in this vision to invest large sums in R&D start-up costs. We went ahead and in 1976 became the first manufacturer to publicly commit itself to a complete line of digital telecommunications equipment.

This investment in innovation is beginning to pay off. Northern Telecom is now the only manufacturer of a full range of digital switching systems in North America. We are broadly acknowledged globally as the leader in digital telecommunications. By the end of the first quarter, 1980, we had sold or had orders for 1462 digital systems worldwide. In addition to supplying these systems to all of the Canadian telephone companies and virtually all the major independent telephone companies in the US, we recently signed a supply agreement with AT&T for one of our digital switches, which we expect will be worth at least \$100 million (US) over the next three years. We have also been awarded a three-year contract by the South Korean government under which our Canadian manufacturing company will supply digital transmission equipment worth as much as \$90 million. Innovation has been and will continue to be Northern Telecom's passport to global markets.

Other companies in Canada, both foreign-owned and domestic-controlled, must be encouraged to step up their R&D efforts if Canada is to emerge as an industrial leader in world competition. But they cannot do it on their own. Economic survival is a national imperative, not merely a corporate decision, and requires the backing of all Canadian governments, at the national, provincial, and local levels.

The decision to substantially increase Canada's investment in R&D must be made soon. Unless we make it, other countries will in effect make that decision for us. We believe that Japan provides 90 per cent support for R&D in its key industries, France and the US 60 per cent, the UK 50 per cent, and Sweden 45 per cent; this compares with a low in Canada of 11.2 per cent. The decision of these countries

to invest in innovation, coupled with our indecision, will determine Canada's future.

Repeatedly, government spokesmen have expressed concern that R&D efforts in Canada be strengthened. The Federal Minister of Industry is ready to go to Cabinet for more money if, as he says, "there are instances where funding is the only obstacle to the capture of important opportunities." A number of provincial ministers have put forth proposals for enhancing their industries' competitiveness. The Global Product Mandating policy of the Ontario government is one such example. Even the US is suggesting that we in Canada should become more technologically self-sufficient. Kenneth Curtis, the US ambassador to Canada, has said that Canadian subsidiaries of United States corporations should spend more on research and development in Canada than they have in the past.

More and more of us, it seems, have come to realize that the emperor has no clothes.

Now, let's do something about it.

DISCUSSION

Killing: Westinghouse is doing exactly the kind of thing that multi-nationals have to be encouraged to do. Are profits your motivation to try to establish world product mandates? Or is it a question of survival when tariffs decrease?

Carman: We see no future for the branch plant in Canada, so the chief motivating factor is long-term survival. Westinghouse is being cast in the role of an ogre in the press, because we are decentralizing our switchgear operations. But in five to ten years that business might have disappeared from our portfolio without the moves we are making.

Killing: How do you convince your United States parent to allow you to become a world product centre? Does the fact that you have a mandate in gas turbines, for example, mean someone in the US became unemployed?

Carman: The United States' turbine division concentrated on the larger end of the spectrum. We have up to 38 000 horsepower in gas turbines for the Canadian entity and similar criteria in steam turbines. In each case, we split the product range rather than splitting the market.

Killing: Why is Westinghouse doing this but other firms are not?

Carman: They are. In the study that we did, contacting 20 to 25 subsidiaries of foreign parents, we found that about two-thirds of them were involved in product mandating to some degree. IBM, for example, is a big company in adopting world product mandates. The Ontario government has set up a committee, of which my President is a member, to study the performance of successful world product mandators, and to see what characteristics might be applied to foreign subsidiaries which are not now practicing such mandates.

DeMello: What sort of criteria are used within the multinational enterprise to select the product which can be world mandated? What was special about turbines that led Westinghouse Canada to get into that area as opposed to something else? Are there economic reasons, or is it because you already had some special expertise?

Carman: It started with a sale to Ontario Hydro in 1970. We developed our expertise and then saw an opportunity to develop an industrial gas turbine for future application to Canada gas pipelines. The parent was not interested in that size of turbine, and when the opportunity arose for the Canadian government and ourselves to go into partnership, it became an economic matter. R&D money was available in the partnership, and the parent had none, it was as simple as that. Other world product mandates in our company have evolved because we have seen similar opportunities, as in our electronics operation.

The process of assuring a mandate is not always the same. Nobody in Pittsburgh, where our parent is headquartered, says that Spain, for example, ought to take something as a world product mandate. The initiative is usually in the country that wants it; that is what has happened in Canada.

Richardson: Westinghouse in the States is involved in the nuclear business in a big way. In Canada, with the CANDU reactor, we have a different nuclear system. What would be your parent's views if you

said we want to get into this technology in a big way and compete in world markets with Canadian nuclear technology?

Carman: We would not say that we wanted to compete "head on" with the parent - that just wouldn't make sense, but there is no objection on the parent's part to our participation on the Canadian team that sells to Argentina. We are already involved in manufacturing fuel bundles for CANDU reactors.

Maule: I would like to discuss technology based on Canadian development. One of the examples that you listed was panel boards. Would the resources expended on that be considered an R&D expenditure? Also, what type of resources are you talking about in that kind of development? What sort of skills are you employing?

Carman: We custom design the panel board to suit the customer. This is not a very complex operation and does not use significant technological resources. A few engineers would be involved, but not many. On the other hand, our display business has grown from zero to about \$12 million and is very profitable. We now export such displays on a world wide basis.

Steed: A recent Fortune article* mentions that there has been a fairly massive reorganization at Westinghouse internationally. The article indicates that your nuclear unit has been operating on the matrix principle in a limited fashion for some time. The likeliest role model is the Canadian subsidiary. Several business units have assigned the manufacture of products to Canada recently, to take advantage of Ottawa's aid to exports. Is that significant?

Carman: Not in nuclear. There are no world product mandates except the fuel, and that was not assigned, but grew with the Canadian CANDU

* Hugh D. Menzies, "Westinghouse Takes Aim at the World," Fortune, 14 January 1980.

reactor. What they are probably referring to are the gas and steam turbine examples.

Pollock: It is significant that Jim Carman said that you must go out and earn these mandates. Nobody in Pittsburg assigns them.

Silverman: We all agree, I think, with the seriousness of the situation in Canada. At the end of his remarks, Dr. MacDonald mentioned the extent to which other governments subsidize industrial research and development in their countries, and stated that, in Japan, about 90 per cent of industrial R&D is supported by the Japanese government, West Germany 80 per cent, the UK 50 per cent, Sweden 45 per cent and Canada only 12 per cent. This leads us to the conclusion that it's the fault of the Canadian government that the situation is not improving. I believe that these statistics might be applicable to the electronics, telecommunications and computer sectors, but I don't think they're applicable across all industry sectors, at least if we can believe what governments are supplying as statistics to the Organization for International Cooperation and Development (OECD) on an internationally comparable basis. If we look at those statistics, across all industry sectors, we find that the West German government funds 18 per cent of industrial R&D, not 80 per cent. I think one must be cautious about transferring figures for the electronics and telecommunications sector to industry as a whole. Not included in these statistics for example, are incentives, which come elsewhere from the tax system. Funding of industry R&D in a foreign country which is carried out in a government laboratory is also omitted. It's quite possible that the effective level of support in telecommunications, computers and so forth, is much higher than appears in OECD's statistics.

MacDonald: I agree with you, but it is important to consider key industries. These countries have a strategy, particularly Japan, the UK, France and Germany. We do not believe the OECD statistics represent the electronics industry's R&D expenditures in Japan and so we compiled our own data. The electronics industry, of course, is a key

industry for Japan. Telecommunications is a key industry for the UK, France, Germany and Japan and the figures apply to electronics and telecommunications.

Richardson: Are you allowing for the incentives and tax write-offs that one is allowed for doing R&D in Canada?

MacDonald: The major tax incentive in Canada is 100 per cent deduction of R&D expenses but this is the same as deducting any other business expense. The other is a 50 per cent deduction of incremental R&D expenditure. To benefit from this you must increase the R&D content each year; it does not affect the base. Finally, there is a 10 per cent tax incentive that is taxable, which turns out to be about 5.0 per cent or a little higher, depending on the tax rate of the industry. These tax incentives sound good, but to a firm with a large R&D budget, they are not that significant.

Northern Telecom does not like grants; we and others view them as handouts. The tax incentive for R&D in Canada should be even greater, since Canada, of all the industrial nations, has the lowest percentage of R&D, less than 0.9 per cent of GNP. That has to be increased, and one of the ways of increasing it is to make the investment in R&D more attractive. That in itself, however, is not enough.

Richardson: Some evidence suggests that in terms of tax incentives, Canada offers one of the best positions in the world today, yet you want more. You do not want handouts, tax incentives are not enough; what do you want?

MacDonald: We recommend tax incentives because they reward the successful.

Richardson: They reward the profitable; they do not reward R&D success. They would enable Dupont to write off R&D expenses against profits. When you give tax incentives, there are companies like Northern Telecom who do deserve it and will take advantage of it in a

just way. There are other companies which will set up "R&D" operations but not do research and development linked to new product or process development.

MacDonald: There is a place for grants and other non-tax incentives because tax incentives do not help firms with cash flow problems get started. But we are concerned about relying solely on grants. Three things in the Canadian heritage have led to most of the industrial problems we identify today: the 1896 policy on tariffs, which led to the branch plant economy; our reliance on resource base industry; and the fact that Canadians seem to want to back losers. We have a social policy that supports the underdog, with which I agree. But unfortunately, it cannot be applied to the industrial sector.

De Bresson: I was fascinated by Mr. Blachford's presentation, because what he described seems to be prevalent in smaller Canadian firms. In my research, I was startled by the number of innovators amongst the smaller firms. The length of the runs of products in these firms were often a one shot affair for one client.

Mr. Blachford gave a ratio of 500 products and 500 clients. How often do you produce the same product? Do you produce only on order? The large technological capability in small firms in Canada seems to have trouble growing into a full fledged industrial capability. In that sector, the adoption of foreign technology or access to technological know-how is important, so that it can be adapted to Canadian needs. Small firms seem particularly good at adaptation. Mr. Blachford, do you view your case as unique, or do you know of manufacturers in chemical specialties or other industrial sectors that function in the same way?

Blachford: I suspect that our case is unique. There are very few small Canadian-owned chemical companies still around. We have not done enough to exploit our development work nor have we made a big enough

effort to export or to establish licensees. We are entering that phase now.

Those figures on patents cited by Mr. MacDonald may not be meaningful. Anybody who applies for a patent in the US automatically goes for one in Canada for the following reasons: Canadian patents are easier to obtain, are written in the same language, are cheap, and do not require renewal fees. The Canadian patent office, however, is always two or three years slower than the US patents office; they seem to want the US patent office to do the work of examining applications for them.

Letts: I would like to point out another example similar to Nothern Telecom. My company, Jarvis Clark, is a manufacturer of underground mining equipment in Canada. We have been developing and manufacturing mining equipment since about 1970. Prior to that time, all the underground mining equipment products, loaders and drilling equipment we sold were imported into Canada from the United States or Europe. In 1970, Jarvis Clark took some of the basic products that were manufactured in the United States, and modified them to meet some unique Canadian needs. We developed some of our own designs and innovations in the equipment. By 1975, we had 80 per cent of the Canadian underground mining equipment market. We had then reached a stage where unless we exported to other markets we couldn't expand very much. We were not under licence or joint venture status, so we were able to develop other markets.

The Canadian market for this kind of equipment represents only 15 or 20 per cent of the world market. The other two large manufacturers of underground mining equipment are from the United States. We had to decide whether to compete with these two giants and capture some of the world market. We had some unique innovative ideas developed in Canada, and a great test facility here in underground hardrock mining. We had the technology, some of the design people, and some of the know-how from working with major companies like INCO,

Falconbridge and Noranda. We had developed some products that were not developed anywhere else in the world. Canada had a good reputation in the world market. Selling these products was not difficult, and the devaluation of the Canadian dollar helped. Price alone, however, was not enough. We expanded our growth, our manufacturing and our products internationally. We've grown from 30 people in 1970 to about 550 people. Sales have grown an average of about 30 per cent a year. Most recent sales have been exports; now they are 50 per cent of our sales, from 5.0 per cent in 1975.

This can happen, but not to every industry. We are in a very specialized business which is unique to Canada. Canada has many mineral resources, therefore we have a natural test site. The expertise for the equipment is here now, but until 1970 it was all imported.

Killing: How much do you spend yearly on R&D?

Letts: Probably about 2.0 per cent of sales right now. We are innovators of mining equipment, not just manufacturers. All our sales people are mining engineers who know mining and they sell a mining method using our equipment and techniques which improves productivity. Many of our products have been designed 2000 feet underground in a mine shaft with a miner, an industrial engineer and an engineer from our plant who try to solve a problem, or to improve productivity or safety. Between them they come up with ideas, which we incorporate into equipment. The mines are very receptive to taking the first product, and pay rent while they use it. Basically, they make it work, along with our help, and it becomes a product that can be used in other mines. We use the mining community's expertise to develop our products.

There are potential opportunities available. We are not looking for government grants or handouts and if they were not available, we would still innovate, although the extent to which we do it might change; we might not spend as much money. With more funds we

could probably develop more products. Between one-half and one billion dollars worth of equipment is imported into Canada each year for underground mining. That's an opportunity for Canadian manufacturers.

Pollock: Is our problem innovation or the application of innovation in Canada?

Blais: Personally, I have no problem about the introduction of multinationals, which I can reconcile with our own national industrial system. One issue that concerns many policy makers and educators is the management of engineering schools. Is the adoption of technologies from abroad contributing in a significant way to developing our own technological capability? What about the innovation capability of Canadians and the diffusion of these innovations?

New products tie in to the innovation process and improve the rate of innovation. More importantly, they improve the attitude on the part of the graduates. This improves the spirit, gives more meaning to the curriculum, and makes individuals better trained in real-life situations. We have a better chance in the 1990s of having another generation of technological entrepreneurs.

It is hard to comment on what gives a nation a more dynamic posture, but there is a need to cultivate such a posture at the beginning, when young people are gearing up for their future careers. If we are imaginative enough we might provide the incubation that creates a desire to industrially innovate among our students. These individuals would also understand the language and the constraints of those working in industry.

Basically, while we in this country will continue to welcome the important inputs of multinationals, we must know what we can do best indigenously. What do we learn from technology transfer? Can we put teams together? Can we encourage companies to develop an indigenous technological base? What sort of help will they need? We could

change the fabric of this country if we had 50 Northern Telecoms, but it will take time. How do we start?

We should not lose sight of one major indigenous resource we possess in Canada - human resources in the universities. The main thing is to pursue excellence and to possess the technical know-how. We must be more aggressive in shaping our technological destiny, beginning with the university.

Canada has a tremendous future, but it will need imagination, enthusiasm, dedication, and work. For instance, Ecole Polytechnique has a unique status in Canada and is very keen to collaborate with industry, but large industry rarely comes to us. We in the universities have to be aggressive, and market our own intellectual capacities.

Lloyd: I want to return to some of the comments that were made about tax incentives. The Canadian Manufacturers Association has spent considerable time studying this issue. These comments are addressed to Professor Richardson's lament that although Northern Telecom would take advantage of tax incentives for R&D, other companies might not. Most companies in Canada are limited by the funds they have available. They have a list of projects, but at a certain point R&D funds run out, since R&D projects compete with other investment alternatives. As you get further down the list, the projects have longer payoff delays and are riskier than alternative investments. If these companies had an R&D tax incentive, investment decisions would be made to undertake those projects. This was the feeling of the member companies that CMA surveyed. It's our view that an R&D tax incentive would be used generally by Canadian industry. One of the advantages of using a tax incentive is that if a company chose not to do R&D it would not get the tax incentive; the government would not forego revenue.

Maule: I would like to address my comment to the second part of Mr. MacDonald's remarks. I agree that Northern Telecom is a success story.

However, it's important for the Science Council to determine why. There are two things in its heritage: its past technical dependency on Western Electric and its association with Bell Telephone Labs which must have led to the transfer of some cumulative experience over time to the Canadian operation as it became independent and developed its own proprietary products. Second, most of Northern's sales have been in an assured, "tied" market. If other companies had those two characteristics, perhaps it would be easier to develop similar success stories. I think we have to understand the background of companies when we propose policies based on actual examples.

Pollock: I think we have that opportunity. The bulk of the electrical generating and distribution industry in this country is owned by government. If we want a vibrant electrical industry, government must support Canadian companies, whether they are wholly Canadian-owned or multinationals based in Canada. If government was prepared to buy more from companies that produce in Canada, we would have a much stronger industrial base and the Northern Telecom/Bell example could be duplicated in other areas of our society. The Science Council has urged government to use government purchasing policy to support Canadian industrial and technological development and the federal government has taken some steps recently which support that view. However, we still have difficulty in convincing some provincial governments that Canadian industry is worth supporting.

APPENDIX A - Agenda of the Conference

ISSUES IN THE ADOPTION OF FOREIGN TECHNOLOGY BY CANADIAN INDUSTRY

Thursday, 15 May 1980

Science Council of Canada Board Room, 16th Floor, Room 1627,
100 Metcalfe Street, Ottawa

- 9:00 a.m. Introduction and Welcome
R.D. Pollock
Chairman, Industrial Policies Committee of the
Science Council, and Chairman of the
Ontario Manpower Commission
- 9:15 a.m. Trends in the Transfer of US Technology to Canada
W.H. Davidson
Amos Tuck School of Business administration,
Dartmouth College, N.H.
Further Comments: W.H. Davidson
Open Discussion
- 10:00 a.m. Industrial Patterns in Early and Late Adoption of New
Products in Canada
C. DeBresson
Science Council of Canada
- 10:15 a.m. Comments:
P. Richardson
School of Business
Queen's University
J. Britton
Department of Geography
University of Toronto
- 11:15 a.m. Technology Acquisition: Licence Agreement or Joint
Venture
J.P. Killing
School of Business Administration
University of Western Ontario

- 12:00 Comments:

 C.J. Maule
 Department of Economics
 Carleton University

 D. Demelto
 Economic Council of Canada
- 12:25 p.m. Open Discussion
- 12:45 p.m. Lunch (Hosted by the Science Council)
- 2:00 p.m. The Experience of Canadian Business:
 A Panel Discussion

 J.K. Carman
 Vice President
 Westinghouse Canada Ltd.
 Hamilton

 J. Blachford
 President
 H.L. Blachford Ltd.
 Montreal

 John MacDonald
 Vice President Technology Management
 Northern Telecom Canada Ltd.
 Toronto
- 1:00 p.m. General Discussion
- 4:00 to
5:00 p.m. Reception

APPENDIX B - List of Participants

Mr. R. Donald Pollock
Chairman
Industrial Policies Committee

M. Roger Blais
Doyen à la recherche
Ecole Polytechnique
Campus de l'Université de Montréal
Montreal

Dr. John Britton
Department of Geography
University of Toronto
Toronto

Mr. Wayne Chevaldayoff
Economics Correspondent
The Globe and Mail
Ottawa

Dr. D. Demelto
Director
Research Group on Technological
Change, Productivity & Growth
Economic Council of Canada
Ottawa

Mr. Louis Erlichman
Research Director
International Association of
Machinists and Aerospace Workers
Ottawa

Dr. P. Killing
School of Business Administration
University of Western Ontario
London

Mr. D. Letts
Vice President, Manufacturing
Jarvis Clark Company Limited
North Bay

Gr. J. Blachford
President
H.L. Blachford Limited
Montreal

Mr. J.K. Carman
Vice President
Westinghouse Canada Limited
Hamilton

Dr. W. Davidson
The Amos Tuck School of
Business Administration
Dartmouth College
Hanover, New Hampshire
U.S.A.

Mr. Frank Doyle
Chief, Technology Transfer Div.
Technology Branch
Department of Industry,
Trade and Commerce
Ottawa

Dr. S.S. Grimley
Director, Industry Policy
Analysis & Evaluation
National Research Council
Ottawa

Mr. Stephen Lau
Economist
Industry & Trade Analysis Branch
Ministry of Industry & Tourism
Government of Ontario
Toronto

Mr. Gordon Lloyd
Manager, Technical Department
Canadian Manufacturers Association
Toronto

Mr. John E. Lockyer
Vice President, Technology
Spar Aerospace Limited
Toronto

Dr. C.J. Maule
Department of Economics
Carleton University
Ottawa

Mr. Donald Morrison
Corporate Planning Analyst
Colanese Canada Inc.
Montreal

Mr. O. Silverman
Director
Industry Branch
Ministry of State for Science
and Technology
Ottawa

Dr. John MacDonald
Vice President
Technology Management
Northern Telecom Limited
Mississauga

Mr. J. Mills
R&D Division
Soci  t   Surveyer Nenninger et
Ch  nevert Limit  e
Montreal

Dr. P. Richardson
School of Business
Queen's University
Kingston

Mr. Robert Steklasa
Science & Technology Correspondent
Financial Post
Ottawa

Science Council Staff

Dr. James Gilmour
Dr. M. Jenkin
Dr. G. Steed
Mr. C. DeBresson

